THE

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AT a meeting of the Agricultural Club held during the fall term of the present year, it was decided to issue an annual publication which should contain matter of interest to every one connected with agriculture.

In presenting this, the first issue of the publication, we do so trusting that those connected with agricultural work may find something of interest in its contents. The matter herein presented has been contributed by members of the Agricultural Club, professors in the University who are closely allied with agricultural work, and persons not directly connected with the University who are among our most prominent agriculturists. We wish to thank all those who have assisted us in the preparation of this book.

The object of the publication, as already intimated, is to advance agricultural interests in general, and especially to stimulate a desire for an agricultural education.

If our efforts have in any measure succeeded in fulfilling the objects of this publication, we shall feel amply repaid for our work.

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THE EDUCATION OF THE FARMER.

BY J. ARNOLD TOMPKINS, PROFESSOR OF PEDAGOGY.

A farmer should be educated that he may have practical efficiency as a farmer. Other things equal, a correct knowledge of what one has to do measures his efficiency. Surely one can do better that which he is able to think out intelligently. In these days there is a cheap denunciation of theory as being something airy and speculative, and as having no direct relation to practical duties. Now, theory is only practice in thought and practice is only theory at work. A theory which fails to work fails not because it is theory but because it is incorrect theory. Theory is only one's sense of the situation and to say that a man can farm better without theory than with it is to say that he can farm better without sense than with it. The so called practical man who denounces theory does so by means of theory and thus raises theory to the second power.

It would be strange indeed that, while all professions and all other occupations are grounded in principles and have their respective sciences, farming should be a matter of luck, or at most of main strength and awkwardness. Nature imposes laws and conditions which the farmer must intelligently obey and utilize. And this is more than a mere matter of watching the conjuncture of the planets. The farmer must keep nearer earth. He can not even plant his potatoes in the moon. This unscientific stage of farming is being rapidly supplanted by the scientific stage. What is still worse than faith in planetary influences is the belief that some sort of legislative hocus pocus can determine the weal or the woe of the farming business; that times are made good or ill by the shifting of governmental policies. No sort of tariff measure could possibly avail so much to the farmer as the sheltering of his ox and his wagon and the caring for them both with scientific sympathy. The farmer must have scientific faith in the thing he is doing and meet the problem squarely and on its own

ground. The factors which determine his success are the natural conditions and his own intelligent industry. The more brains he puts into his work the more efficient and remunerative will be his labor. There is a great difference between farmers who toil with equal assiduity under the same natural conditions of success, and this difference arises from the difference in the intelligent manipulation of the conditions of success.

So we should say that a farmer should be educated in the science of farming that he may be a skillful farmer—that he may make his farm more productive and remunerative. But this is only a small part of the reason for being educated to farm. If one could conclusively prove that the uneducated farmer, the unscientific one, can make as much money as the educated one, there would still remain the best reason in the world for educating the farmer. The farmer not only lives by farming but also in farming. He must find a joy and a reward in the work itself. The one who knows the chemistry of the soil and the vital processes of the plant can find a life and joy in his work to which the ignorant laborer is a stranger. A scientific knowledge of domestic animals gives a new attachment and interest to man's rational life. The problem of life is more than the mere sustenance of life and the problem of farming is more than securing material remuneration; there must be an immediate return to the intelligent and spiritual life of man. Man can not live by bread alone and the success of farming can not be measured in the material goods of life. The one who gets the most life out of his farm is the best farmer, but life is more than raiment.

This rational life which the farmer may get out of his farming is exactly determined by the scientific thought which he can put into his work. And this makes doubly strong the reason for the farmer being educated. It is absolutely necessary for the highest life that the man who lives by his work should also find his life in his work. A farmer is not merely a farming man, but a man farming. In all occupations man must keep above his work, not being merely a means to the work but making the work a means to his own higher life. And if the foregoing be true we are prepared to say that the farmer's education should extend beyond the mere science of his work and enlarge his interest to all phases of the natural world about him. He should be a liberally educated scientist. He lives in the immediate midst of a world of miracle and wonder and his mind should be made open and susceptible to its influence. No one needs astronomy or geology or geography more than the farmer.

His chemistry and physics and botany and zoölogy should include more than what is immediately demanded by his occupation.

And more, the farmer being close bound up in an industrial, social and political system should have an enlightened and well balanced judgment on industrial, social and political questions. He should have an all-sided interest in social life and endeavor and be able to think out with clearness and to conviction his own social and political conduct. That he may feel himself to be "the heir of all the ages" a knowledge of history must enable him to pass in review the progress of the human race "in its slow and toilsome march across the centuries toward freedom." As a man the farmer needs a knowledge of other times than his own that his own life may be enriched and fulfilled by the life of humanity. That is, as the farmer must live in the midst of nature and may have his life enriched and ennobled through the natural sciences, so he lives in the midst of humanity, past and present, and should be prepared through the studies of history, economics and sociology for the largest life possible through his relations with his fellowman.

Finally, a farmer's education should include a knowledge of and a taste for good literature. By literature is here meant a peculiar kind of writing which appeals to ideals in human life and exalts the reader into higher sentiments than rules in his ordinary every day life; such writings as have sustenance for the spiritual life and regenerative power in the soul. Life is a movement of the individual towards the realization of his potential and true self. Literature administers unto such life by awakening in the soul a keen sense of its possibilities and thus incites to a higher striving for ideals. Whatever one's occupation and whatever practical wisdom is required he should find time to read, to sustain, stimulate and elevate life. Nothing does the farmer need more than a taste for good reading with a liberal knowledge of literary productions. He should have access to, and be able to appreciate, other companions than the newspaper and be able to find more congenial fellowship in Ruskin, and Burroughs, and Thoreau, and Hawthorne, and the like than with those at the corner grocery. Farming is not successful when it deprives the farmer of the opportunity to utilize the books and the fine arts which appeal to his essential life. There must be hours of leisure for meditation and the reading of stimulating and wholesome books. The farmer who has not time to read Emerson's Essay on Nature, or Self-reliance, or The Oversoul, or Compensation has failed to realize what the farm exists for; and if he has not a greater

relish for such things than for neighborhood or political gossip he has not a good agricultural education.

Along with a taste for the fine art of literature, it should be insisted that the esthetic sense be highly cultivated all round. In no occupation is there a better opportunity to exercise taste and enjoy beauty than in that of farming. The farm itself should be made a beautiful landscape and the farmer should have the artistic sense of a landscape gardener. The farmer who is content with dilapidated buildings, rail fences and barn-lots marred by worn-out machinery and offensive rubbish lacks an essential element of being a first rate farmer. The yield of a properly cultivated farm cannot be measured in bushels; there is a large return in the fullness and joy of life to him who has the esthetic sympathy with the varied manifestations of rural life and activity.

In this outline of a farmer's education it is assumed that the farm is more than a place of mere subsistence; that it is a place of life, of thought, of intelligence, of growth in the essential elements of manhood and womanhood. If the farm means less than this the farmer is no more than the ox he feeds, and then, of course, he needs only that knowledge which enables him to get the most physical comfort out of the farm. This latter is, perhaps, the common view, for it seems quite generally assumed that a farmer needs only that little education which enables him to transact his business in bartering and buying and selling. He should be able to read the markets, draw up a note, count interest and drive bargains as well as to know when to sow and to reap. The farmer himself seems to think that liberal education is needed only in the learned professions. But the farmer, both for the sake of his occupation and for the sake of himself, should have as liberal culture as that required in any other occupation or in any profession. His technical education for his specific work does not at all meet the requirements. A school which is not a cultural school is not an agricultural school and the farmer who cannot cultivate himself while cultivating his farm, and live in farming as well as by it, is lacking in first principles.

ORNAMENTAL PLANTING.

BY T. J. BURRILL, PROFESSOR OF BOTANY.

"This is an art that does mend Nature."

We plant trees for their fruit, for shade and shelter, and for the interest we take in them as individual objects of beauty, as well as parts of an attractive landscape. The first of these purposes can not usually be combined with the others. An orange grove in blossom or in ripening fruit is indeed a charming sight. Scarcely less so is a fine apple orchard during the few days when the sweet-scented flowers delight the senses, or during the longer period when the sun-tinted fruit shows far and near the richness of the crop. But the beauty of an orchard is one thing, that of an ornamental garden or landscape is quite another thing. It is rarely possible to make a fruit tree seem properly situated upon a lawn, and attractiveness of appearance is a matter of association and of combination, more than of individual characteristics, in landscape adornment.

We write now of the other uses of trees, shrubs and herbaceous plants. The two last named purposes of planting, viz: for shade and shelter on the one hand, and for beautiful effects on the other, are closely associated. The shadow cast by a tree is one of its elements of visible attractiveness, and a leafy screen from the public gaze or from chilly winds constitutes one of the charms of ornamental gardening. We must consider the two together, though it is sometimes one or the other to which principal attention is directed. In what follows little heed is given to the distinction.

Planting for fruit is often considered more worthy of the expenditure of time and money than for ornamentation. A man says: "When I plant a tree I try to select something that is valuable, something that will repay the expenditure of time and labor." He means something that will bear edible products. He has not yet duly appreciated that there is hun ger of the eye just as insatiate as

Illustrating the use of flowers and foliage plants with background of trees.

that of the stomach. The latter develops earliest with the individual and with the race. At first something to satisfy its cravings is more important. Life itself depends upon it; but, if one lives only to eat, he might just as well have been born an alligator or a turkey buzzard. The eye appetite needs encouragement; indulgence in this case is no sin, but strength of habit follows just as surely as in the use of narcotics. When once the hunger of the eye is aroused it is never appeased. A feast is richly enjoyed, but the call is perpetually for more, and more does not surfeit. In this case it is very certainly true that to him that hath shall be given. We all may be rich in this respect, and our riches impoverish no one else.

Let us therefore learn to plant trees, and to make lawns and gardens, without thinking it necessary to excuse ourselves if we look for other returns than crops or products saleable in the markets. Indeed, financial acumen will often prompt this course. Nothing more assuredly grows into money value in many cases than shade and ornamental trees, and certainly nothing brings more for the investment in the making of a home with all of its endearing associations and fond attachments. A suburban or rural home without beautiful trees and flowers is almost a misnomer. What a cold, repellant idea! Who could write in such case, "There's no place like home?" Who could wish to carry the picture forever in memory of leafless grounds and sun-burnt walls? Plant for present enjoyment; plant for the children's sake; plant for the return contributions nature generously makes to him who will accept the gifts.

HOW TO PLANT TREES.

Very few transplanted trees fail to start freely the first spring; they much more frequently perish during July or August of that year. Sometimes they shoot forth the second spring and then die in midsummer. This last is more liable to happen when large trees have been moved. It all means that care should be taken to keep the conditions favorable during the hot, dry parts of the summer, rather than that chief attention should be paid to the good of the tree during a short time after planting. Digging a hole just big enough for the roots in sodded or uncultivated ground is not enough. Putting manure around the roots, and pouring in water while setting a tree are harmful practices. This water cannot last long. It leaves the earth in bad order when the midsummer trial comes. If watering must be practiced, do it when the added moisture will be serviceable. If manure is to be added, place it on the surface as a mulch, and if enough is thus used, spread over a circle six or more feet in diameter,

the retained moisture will usually suffice. A good mulch is far better than artificial watering in most cases.

One of the most important considerations in tree planting is the firming of the earth about the roots. Many losses occur from neglect of this, though they are usually attributed to something else. See to it that fine earth is closely pressed in about all roots and that no holes are left in the soil. This not only better serves to keep the tree steadily in place, but gives the mutilated roots a chance to absorb water and properly to start new growths.

Hardy kinds are best planted in the fall—early in October. Others should be in position in spring as early as possible—as soon as the earth can be handled without subsequent "baking." The magnolias, tulip tree, and a few others with very soft, poorly branched roots, transplant best just when the buds are ready to burst into leaf; but this is exceptional for deciduous trees. Evergreens usually succeed best in rather late spring, just before growth starts. Shrubs are easier handled than large trees and as a rule are transplanted with less risk; but the same rules apply and the same care should be exercised.

In all cases it is best to cut back the tops in such manner that at least one-half the foliage will be removed. It is not wise to prune so as to leave only stumps of large limbs; head back all of last season's growth, the part which bears the leaves the current season; these evaporating organs must not be allowed to overwork the mutilated roots.

WHERE TO PLANT.

It needs educated experience, and a qualified imagination in the selection of the situation for, and the proper association of trees. Either the individual specimen, or a group, is to be thought of as the unit. In regard to the first, a very common fault is to place the trees too near together. They are usually small when set, and we fail to appreciate what subsequently we see too clearly, that they need more room. On streets and avenues fifty feet should be the minimum for large growing kinds. How often are they planted less than half this distance apart? If one does not want to wait for effects, and he is sure of his courage, temporary, quick-growing kinds may be alternated with those intended for permanent use, and then at the proper time apply the ax. It will seem savage, but in this case it is high art, not in anywise to be neglected.

On residence grounds, mistakes are made in the same way. There is room enough for small trees, but not enough for large ones

to the number planted. They are all right at first but all wrong afterward. If large-growing kinds are used, see to it that they have room for proper development. Very much better in many cases, select those which do not attain great size. In either case temporary specimens, to be removed at the proper time, may be profitably used.

In group planting on limited areas the individual trees are not expected to become perfect specimens. They are too closely associated for that. The central ones should rise above the others and show well at the top without much heed as to the lower branches, while the exterior specimens are to present their best effects from the side view. To attain these results the proper kinds must be selected and proper pruning aud shaping must be observed Of course the study of distance must also be well made.

The farm home is especially improved by the proper use of trees and shrubs. The towns have other attractions, besides the impurities of the air prevent the best growth of many kinds. Happily Illinois farmers have appreciated the improvement. What a change has been brought about by the tree planters on our broad prairies! There are no prairies now in our state, and there are few dwelling houses not more or less surrounded by artificially planted trees.

Still there is much room for improvement in the selection of kinds and in the most effective arrangement. Let us attend for the moment to this. Those planted for winter shelter should of course be on the west, or the west and north. They should be somewhat evenly distributed, at least with no wide spaces through which the winds can sweep. Need they be in rows, regularly spaced? They usually are. They can be kept cultivated when young easier so. Possibly some have not yet learned to see the disadvantages from the standpoint of appearance. A little more labor at first would be richly repaid by imitating the natural grove rather than copy from the cornfields. Then too a mixture of kinds is both better in appearance—after nature again—and better for the trees themselves. We ought to have learned by this time that deciduous-leaved trees do not thrive well, even when favorable ground to the species is chosen, in groves solely of one kind. Pines and spruces seem to delight in such association, but the others mentioned crowd one another near to the death when given fully sufficient room for mixed planting. Nature does better and Nature is a good teacher in this department. Deciduous trees of mixed kinds form the best body for a sheltering grove, while a few evergreens on the borders in irregular

FRONT YARD BEFORE PLANTING.

THE SAME FRONT YARD AFTER PLANTING.

projecting clumps add much, both to the wind break and to the landscape.

Of course the farm home should have a lawn. Nothing takes the place effectually of grass, and be it known that no grass in the world equals for this purpose our common blue grass. "Lawn mixtures" are extensively advertised by seed men, but blue grass beats all others in our soil and climate.

Now on the lawn a few single trees, mostly deciduous-leaved ones, should be planted well apart from others. These may be located with reference to views from the windows, and from the roadway. One, perhaps not more, may tower up near to and above the house, preferably on the west as a shield from the afternoon sun. Do not permit rows anywhere. Leave wide stretches of open grass in front of the house, that it may not be shut out of sight from the thoroughfare or from the open fields. Plant a small group at the gateway located not directly in front. Arrange others at the sides, still avoiding rows and leaving well spaced openings. See that barns and outbuildings are partially screened from the main view by irregularly planted groups. Near the house (save as indicated above) use shrubs instead of large trees and also use them here and there as out-plantings from the groups of trees. Train creepers or twining vines up the veranda posts and along its horizontal structures. If there is no front porch or veranda, make a support of poles, and give hardy vines a chance to furnish shade for you. At the kitchen door grape vines may be invited to render the same service, notwithstanding our general rule to keep the fruits separate from the decorative plantings.

Do not imagine all this requires much outlay of labor or means. In fact, if properly arranged, the number of trees and shrubs, aside from a grove for shelter, need not be great, better not be great save on large areas and with ample attention. But the effect is remarkable even in a few years, and the home soon becomes much more than a mere habitation; it is a place in which to live, not simply one in which to stay.

KINDS TO PLANT.

A few words as to the selection of varieties. Fortunately we have much to select from. Our native forests furnish splendid material for landscape art, and nurseries are usually well supplied with the best of introduced kinds. Only a few can be mentioned.

For streets the American elm and hard maple claim first notice and for wide roads and openings the first of these is the best. They

are also favorites for lawn planting though others vie with them in this even where they are most appropriate. The box-elder varies greatly according to what the florists would call the strain. Sometimes the trees are straight and symmetrical in development, sometimes crooked and irregular. They are very hardy, quick growing when young and good ones are fairly beautiful. The soft maple is one of our most beautiful trees but needs better care than it gets. It suffers from wounds and when allowed to fork or branch improperly is liable to break down in storms. If it were not so common and so badly used our list could not proceed far without it. The Kentucky coffee nut has been singularly neglected. It has a beauty all its own; as a medium sized tree on the streets, or on the lawn as a single specimen, it has much merit. In the central and southern parts of our state the tulip tree and the cucumber magnolia, for avenues or single planting, are admirable kinds. The hackberry ought not to be omitted. No tree is hardier or withstands, uninjured, worse treatment. It will thrive on tenacious clay and on fertile loamy soil. The white, the green, and the blue ash do well on streets; not so desirable for lawns because grass does not thrive under them. The hardy catalpa and buckeye, or better for the southern half of the state the red flowering horse chestnut, are conspicuously different from others and serve to give a pleasing variety to plantations. Of evergreens the best are white and Austrian pine, Norway, Colorado blue, and hemlock spruces, arbor vitæ. The latter and the Norway spruce make excellent hedges.

The larger growing shrubs include lilacs, snowball, mock orange and bush honeysuckle, while among the best of the smaller kind we have wigelias, several sorts, three or four spireas, barberry, hardy hydrangea and Japanese quince.

Among climbers we must include the Virginia creeper and its finer leaved relative from Japan (Ampelopsis), wistaria, Dutchman's pipe, and clematis.

There are many other trees and shrubs desirable on large grounds or for special purposes, but charming effects can be easily produced with those named, and all of them, save those recommended for southern localities, are entirely hardy and all are likely to thrive wherever placed in our soils.

MR. RALPH ALLEN.

SELECTION OF COWS FOR THE DAIRY.

BY RALPH ALLEN, CLASS OF '76.

The purchase of a cow is often one of the momentous events of rural life. A good cow is always wanted, but how to know a good one from a poor one is the question. The ability to know a good cow at sight comes to a person by long association with them and by study of form and qualities that are common to most good cows until a type or ideal of what a good one should be is formed in a person's mind.

This ideal is a mental picture formed, as we might say, like a composite photograph, by the impression in the mind of all the good cows the person has ever seen. In forming this ideal it is a great help to learn from the knowledge and experience of others what those qualities are that most people look for in a good cow. Most people select the fresh cows, that is, those lately calved. If a cow is ever in her glory it is soon after calving. Whatever dairy merit she may have is then easily seen by the dullest observer.

It is at this time that the seller should sell, for he can never hope for his cow to make a better appearance. While nearly every purchaser demands a fresh cow and will pay proportionally higher for her, it always seemed to me more business like to buy a cow that is due to calve in a short time, for besides the fact that there is less competition among buyers it is also a fact perhaps not generally considered that very many cows will give more milk on the premises where her calf is born than she will anywhere else. The excitement of changing location, the newness of the surroundings and associations act like homesickness on the nervous temperament, so that most cows do not do as well after the change.

I have known several extreme cases of cows that were so much affected as to be quite useless until another calf was born. Careful handling at the time of changing to her new home helps a great deal toward keeping a cow in good working order. I dislike very

much to have a cow driven away, it is much better to lead her or better still to haul her in a stock rack.

Another thing that most purchasers insist upon is that the cow have large teats. A great many short-teated cows are easy and fast milkers, but too many are so tedious it is almost as much as the milk is worth to milk them. I have often thought that slow-milking cows were as a rule not as large milkers as the easy ones. The teats should be large around and long enough to grasp easily. A neighbor once looking at one of my cows inquired if she was not hard to milk. I was rather surprised, for he had not tried her, and although she had large, long teats she was a very hard milker. He told me in explanation that most hard milkers had teats tapering to a point. My observation since has corroborated his assertion. The easy milkers usually have teats square or blunt at the end.

It is not common to find a perfect udder, but a great many cows that have not prize-winning udders are perhaps just as good milkers, yet there are a few qualities common to the udders of most large milking cows. The two most important are texture and attachment.

The texture should be skinny, not fleshy. After milking the udder should be perceptibly smaller and have a shrunken appearance, especially if the cow is an old one.

The attachment of the udder to the body should be considered as important, as it covers the largest amount of body surface. This does not necessarily imply a large udder, for many large udders have small attachments. The heaviest milkers have udders beginning high up behind and extending far forward beneath, and wide in proportion. The conformation of a cow in these parts should be such as to favor an extensive udder.

We not only want the udder to cover as much of the surface of the body as possible, but we want an extensive surface to cover. The good cow is long, wide, and deep in the hind parts. The size of the pelvic bone is a good indication of length and breadth.

The legs should come down straight from the hip, so that the cow will be as thick through the stifle as through the hips. The muscles of the legs should be flat rather than round, giving more room for the udder.

Apart from the cow's milk-making machinery I consider that constitutional vigor is of first importance, although it is seldom considered by purchasers. No matter how well developed the udder and its milk secreting organs may be, they cannot be efficient unless there is a powerful digestive apparatus, heart and

lungs to correspond, with which to convert grain and grass into blood to supply the milk-making machinery.

I have been taught this truth most forcibly by the cows themselves. I never had a flat sided cow that could consume and digest food like a round bodied cow. They always fail when extra work is expected. The well sprung rib is one of the best indications of strong constitutional vigor. The body need not necessarily be deep through the heart, but wide or rounded.

There are some minor points about a cow that attract the attention of buyers, that are worthy of more or less consideration. The horns are always noticeable and as a matter of good looks I like to see them small, waxy, and crumpled. But I never could find anything about a cow's horns that would indicate in any way her worth as a milker. I do not practice cutting them off, but have seen the appearance of many cows improved by the operation.

The color of the skin should preferably be a rich yellow, yet it can be considered as only an indication of the color of the milk and butter, without being an indication of the quantity of milk, or its richness. The intensity of the color of the skin, like the color of the butter, is a physiological quality, but it is largely influenced by feed. When the feed contains a great deal of chlorophyll, or the green coloring matter of plants, the skin tallow and butter will have a golden yellow color. When this is deficient the color becomes pale. It is necessary therefore when comparing different animals with reference to color of skin to consider the feed they have subsisted on for some time previous.

The escutcheon or up-growing hair on the udder, especially behind, has received a great deal of attention from breeders of fine bred dairy cattle. I well remember when about seventeen years old purchasing "Guenon's Treatise," and while I studied it, it seemed to afford me an easy way to know a good cow. Then when standing book in hand behind the cows, how complicated it all became! The escutcheons on the cows never seemed to quite fit those in the book. The conclusion that I came to about the matter was that the best cows carried the largest escutcheons, but the best cows also carried udders that covered the largest surface of the body, and as the escutcheon is mainly the covering of the udder, so the whole argument reduced itself to the fact that the best cows carry extensive udders.

The general form of a cow is quite a good indication of her worth. The old saying that a good cow is shaped like a saw is a

very true one. Looking at the cow from the side, the lower line of her body should drop down as it extends backward. The upper line of the body of many good cows rises as it extends backward. Such cows are higher from the ground to the rump than they are when measured at the withers.

Besides these recommendations of merit that a cow carries with her the use of weight and tests may also assist in determining a cow's worth. I kept a daily record of yield of the cows in my herd, beginning with the desire to know by this means which were my best cows. As I had usually done a portion of the milking myself I soon found that this weighing only told what I already knew, that is, which were the largest milkers. I continued the practice because of the salutary effect it had upon the hired help.

The use of the Babcock Milk Test in my herd was not as productive of important results as might have been expected had the cows comprising my herd not been so nearly alike in breeding. They are all pure bred cattle of the same breed and all descended from the same animals and it is but natural that the quality of their milk should be nearly alike in all the cows. But in a herd composed of cows of diverse breeding, and especially where different breeds are represented, this test must be of great value, for there is no other practical method of knowing the quality of a cow's milk.

At first thought it seems that by knowing the amount of food consumed, the weight of the milk and its quality, that the exact worth of a cow could be determined. But the vital function of giving milk is very hard to measure. If these tests are not used with proper judgment they may prove very misleading. Frequently the work a cow may do today may depend on what she did some time ago.

I once sold a cow with her second calf to a gentleman who was a very skillful feeder. The cow had done unusually well during her first period of lactation; she had good ancestry and was splendidly formed, so that I thought she would prove to be a cow above the average, and recommended her as such. I met the gentleman several months after the sale. He had kept account of her milk and butter yield as well as of her feed. He told me he was not quite satisfied, and he said the cow ate well and looked well, but did not give the amount of milk and butter she should for the amount of feed and attention she was receiving. He told me this not to find fault with his purchase, but to know what he had better do. Knowing his skill as a feeder, I knew that the cow must be up to her

present capacity as a milker and that the extra feed she was taking more than she could make into milk was being stored somewhere in her body, and could be drawn upon at some future time.

I therefore made the promise for the cow that if he would keep on feeding and taking care of her as well as he had been doing until her next calf, that she would pay him back the principal with interest for all he had given her. He replied that he would do so. He kept his promise and the cow kept mine, making more than two pounds of butter a day for a long part of that period of lactation.

With her next calf and the succeeding ones, while she did well, she never did so well as with her third calf. Now the real history of the case was that, when the first period of lactation began the cow was fat and strong as most heifers are; when she commenced giving milk her whole strength was given to that object, even drawing upon her stored up forces. When the second period began she had no reserve to draw upon. She also resumed her growth, which had been checked at the first period, so that as regards dairy work the cow rested during this period, and the extra feed given her was stored for future use, all of which she drew upon during her third period of milking.

Now, any milk and butter test made during these three periods of lactation could not have been used for correctly measuring the cow's ability as a milker. Tests made the first or third period would have overrated her, and tests made during her second period would have underrated her. Such instances as these are very common, with variations often greater. Weighing and testing should only be used as helps toward knowing a cow's worth and should never be placed above one's judgment.

IRRIGATION FOR STRAWBERRIES.

BY ALVIN C. BEAL, CLASS OF '97.

Frequently during the last few years the strawberry crop has been cut short by drought in the early part of the picking season. One or two good rains in this period would have rendered a good crop certain, for the plants were well set with fruit. The fruit grower after the labor and expense of growing a fine berry patch has had his hopes of a just return destroyed by a few days of hot, dry weather. In 1895 the strawberry crop after having suffered from frost was still farther reduced by drought.

Not only is the crop injured but it is difficult to obtain a good stand of plants. The rows have long vacant places in them and the remainder of the row may be uneven in width. The plants are often weak, with poor root development and incapable of producing strong fruit buds or of withstanding winter freezing. The plants which may be produced after the late rains are not certain to yield fruit. Many old fruit growers say that plants produced before August 1st are the most certain to produce a crop.

Often growers desire to plant in the fall, but it is frequently too dry for the recently transplanted plants to live.

To destroy insects and plant diseases, strawberry growers like to mow their patches and burn the leaves and mulch straw as soon as they are dry. If this is done in a dry period, which continues very long after the burning is done, the grower is almost certain to lose his plants. Again, it is very difficult to cultivate an old patch. I have seen the ground so hard in a strawberry patch at the end of the picking season that in order to narrow down the rows a twelve-inch plow had to be used. In order that this plow could be used it had to be sharpened every half day. Land in such condition is hard to get in shape again, even if we succeed in plowing it. The row of plants cannot be renewed unless this can be done.

These conditions are the result, not of too little rainfall, but of

Showing method of irrigating strawberries at the Wisconsin Experiment Station

an unequal distribution of it. Many people, observing how rarely it is that we do not have a dry period some time during the year, have begun to devise some way of saving the water necessary to enable the plants to withstand the drought. One of the means employed is irrigation.

West of meridian 100° water necessary to grow the crop must be supplied. This means that great quantities of water must be brought upon the land. Many people think if we cannot do this in the east we cannot irrigate. But in many seasons we do not need more than two or three inches of water in order to escape the effects of dry weather. One inch may save a crop when the needed rain happens to be a few days too late. Then the crop is injured too much for the rain to restore it.

The experiment stations of Wisconsin, Michigan, West Virginia, and New Hampshire have tried irrigation with excellent results. It was also tried at the Illinois Hospital for the Insane at Kankakee with success. Some gardeners and fruit growers have also been successful with irrigation.

That we may irrigate we must have a supply of water. This supply can be obtained from running streams or from lakes and springs. Where such sources of supply are not accessible ponds or large tanks can be constructed.

A large cranberry grower of Massachusetts constructed a dam across a small stream and obtained water enough to flood 1,000 acres. A Maryland farmer dammed a small brook and irrigated 40 to 50 acres.

A pond 60x60 feet square holds enough water for each foot in depth to flood one acre one inch deep.

In southern Illinois it is easily possible to make ponds either by damming small streams or by catching the storm water from the hills. A number of large ponds have been made by these methods. Some cities are supplied from such reservoirs. In some places it will be necessary to puddle the bottom and sides in order to make the pond hold water. Driven wells are sometimes sufficient for small areas.

If the source of supply is not located so that we can cause the water to flow upon the land it will be necessary to use some kind of power. For small areas wind power can be used. But for any considerable area steam is necessary. The Wisconsin station used an ordinary ten-horse power threshing engine, which pumped 80,100 cubic feet of water for each ton of coal burned. Three thousand

Illustrating effects of irrigating strawberries at the Wisconsin Experiment Station. The nine plates from an irrigated row. The one plate represents all that could be gathered from the same length of row not irrigated.

six hundred and thirty cubic feet will cover an acre one inch deep. Thus 80,100 cubic feet will cover 22 acres one inch deep.

The water may be distributed by tile laid under the surface or by surface irrigation. The first is claimed by some experimenters to be more economical of water than the latter. Besides the advantages derived from having the tile in the ground ready for use year after year, the soil does not bake and the ground can be worked at any time. The soil does not become sour, because the tile holds the excess of water and admits the air. It has been found that considerable of the water supplied sinks away and enters the drains. With a sub-soil such as we have in southern Illinois this system may work. If it is found to work well it is the best system for the reasons given above. A modification of this system was successfully used at the West Virginia experiment station. The tiles are placed on the surface and are used to conduct the water along the rows of plants. The water escapes from the tile and is in reach of the plants.

Surface irrigation is more generally used. The water is taken to the highest part of the field and caused to flow along the rows. One man must regulate this flow.

Professor Goff of the Wisconsin station brought water upon the patch by means of a long trough made of boards 10x12 inches wide. These boards were nailed together at right angles. The trough was supported by stakes, and was built entirely across the patch. In one side of this trough at intervals of 3½ feet were ¾ inch holes to allow the water to flow out into the space between the rows. The holes were closed with strips of galvanized iron.

A certain number of these gates were opened and a man, by using a hoe, directed the water where it was needed as it flowed along the rows, the man walking on the dry ground.

Patches thus irrigated, just as the fruit began to ripen produced almost twice as much as the unirrigated.

The cost will vary according to the power used. The cost with steam may be as high as 66 cents per acre-inch. Some men use water costing $1.50 per acre. When we consider that two or three inches will entirely save a crop of strawberries we must acknowledge that it will pay. The irrigation by means of tile is more expensive because of the cost, but where it is practicable this system is permanent and the saving of labor in distribution will pay for the tile in a few years. Every fruit grower should see if he has not a few acres upon which he can try irrigation. Make the wetting thorough when you do irrigate and study well the results.

DISEASES CONNECTED WITH FOOD.

BY DONALD M'INTOSH, PROFESSOR OF VETERINARY SCIENCE.

The connection between food and disease has been studied thoroughly and is now well known. There is no single factor which exercises so much influence on the health of the animal as the kind, condition and quantity of the food. Men feed their animals with as little discretion as they do themselves. They are either fed on large quantities of highly nutritious food or underfed on badly prepared food unsuited to their digestive organs, and at irregular intervals. There is a great tendency to overfeed animals, especially the horse; and as a consequence it will eat nearly double the quantity that it really needs. Large quantities of hay are placed in its manger at night and the animal stuffs its stomach until by degrees the walls become so distended that they are weakened and digestion becomes impaired, gases form, giving rise to overdistention and sometimes rupture, or the half-masticated food passes out into the intestines and gives rise to colic, or if not colic, indigestion. Overfeeding causes other diseases also, such as lymphangitis (swollen legs), azoturia, congestion of the liver and other fevers. Underfeeding and irregular feeding are also great causes of colic, indigestion, inflammation of the bowels, and various skin diseases. The kind of work the horse has to perform will have a great deal to do with the amount of food required to keep up the system.

In the spring of the year, when the horse has to work hard and is long hours in the field, it requires to be well fed, in fact overfed, to keep up its strength, and this is done at the expense of the horse's health, and a great many horses get sick from this cause. The diet of those that are kept for light work can be regulated so that their stomachs will not be overfilled, and therefore we find less stomach trouble among that class of horses. There is a great deal we can do to assist in cases where we have to cram the stomach in order to keep up the strength, by selecting the best and most easily digested food, and by feeding it at proper intervals, and in the best way.

Timothy and clover hay should not be cut too green or when over-ripe. In the former case it lacks the amount of albumen and in the latter it has lost some of its nutrition and contains too much woody fibre, which is not digested. The best time to cut timothy is when it is in full bloom or as the bloom is about to fall, as it has been found to be the richest in nitrogenous principles at that time; the drying reduces these and the woody fibre becomes thick, dry and hard, which renders it less palatable to the horse and more or less indigestible.

We now turn our attention to the oats. They should be well cured, bright and clean, and weigh not less than thirty pounds to the bushel. Oats lighter than this contain too much hull, which is not nutritious and which acts as an irritant to the bowels. Musty oats or hay is injurious if not dangerous to the life of the animal, and should never be used for horses' food, in fact it cannot be fed to any animal with safety. Corn is not a good food for horses, for they become fat and lazy and do not stand the work nearly so well as when they are fed on oats. Five thousand two hundred horses of the Austrian army were fed on corn for one year, and at the end of that time they were found to be in good flesh, but were lazy and lacked spirit and vigor, so the corn was discontinued and replaced by oats. Oats, no doubt, is the food par excellence for horses, for besides being rich in all the materials necessary for the strength and vigor of the horse, it contains an alkaloid which acts on the nerves as a stimulant.

Wheat bran is also a good addition to the food of the horse, as it is rich in nitrogenous matters, and the fats are much greater than in wheat, but the cellulose is very great. On this account animals could not live on bran alone, but it is a useful adjunct to other foods. Analyses show bran to contain cerealine and one other nitrogenous principle which acts on starch, converting it into sugar. The addition of bran to the food may assist in the digestion of starchy principles. Besides this it acts on the bowels as a laxative by mechanically increasing their action and is therefore an important article of sick diet. On the other hand, if it is given in large quantities it is apt to undergo fermentation, causing colic or even rupture of the stomach. A bran mash should be made with boiling water and covered until cool and should never exceed four quarts of bran at one mash. It should not be kept long, as it is apt to sour and is then unfit for food.

The straws of the different cereals used as a food are generally

oat or wheat straw, and corn fodder. If straw is intended as a food for general use for stock it should be cut on the green side, otherwise if it becomes overripe, the amount of nourishment is greatly decreased owing to an increase in the indigestible fiber. Straw should be clean and of a bright yellow color, sweet to the taste and of a pleasant odor. If the straw is mouldy it is unfit for food and is likely, if fed, to cause disease. A great many of the obscure diseases in cattle are the result of eating mouldy food. As compared with good hay, straw is deficient in nitrogenous matters, containing excess of cellulose, but rich in carbo-hydrates (sugars and fats), and is a useful material to furnish bulk to grain food. Wheat straw is considered the best by some, as horses seem to like the taste of it better than other straw, but its chemical composition shows it to be inferior to oat straw. Oat straw is more digestible than the others and is more nutritious. Voelcker states that the cellulose and indigestible fiber are better balanced than the other straw and unhesitatingly declares that it is the most nourishing of all. Barley straw is considered very indigestible. Corn fodder, when it is cut before it gets too dry, is very good for cattle, but not so useful for the horse, although it could exist on it. It contains considerable nitrogenous matters, but when it becomes very dry these are replaced by an excess of cellulose and becomes more or less indigestible. This, like the other straw, to be fit for food, should be sweet and free from mould.

PRINCIPLES OF FEEDING.

Horses—The stomach of the horse is small in comparison to the size of its body and therefore cannot thrive on bulky, innutritious food. The length of time occupied during stomach digestion is generally in proportion to the amount of nitrogen contained in the food, thus hay and straw pass out of the stomach more rapidly than oats. According to Colin's experiments, hay given after oats causes the latter to be sent into the intestines before being fully acted upon by the stomach; he argues, therefore, that the logical method is to give hay first, then oats. Water given in quantities washes the food out of the stomach into the intestines before it is digested, thereby causing a loss, and that portion of food which should be acted on by the juices of the stomach passes out without the animal receiving any benefit from it, besides often causing colic or some other derangement.

The proper method then of feeding is first to water, then to give hay followed by oats or corn, and at least half an hour should be

given the horse after it has eaten its oats before putting it to work. If this is carried out and the animal not given too much food, digestion will go on with comfort and benefit to the horse. The stomach begins to empty itself very early after the commencement of a meal. As soon as the stomach has attained a certain volume, materials pass out, and the amount so passing corresponds with the quantity being eaten, so that its capacity remains about the same. From this we see that a horse should be fed on food of small bulk, also that an animal should not be allowed to grind hay all day or night, for if it continues to eat, some of the food will pass out into the intestines before it is properly prepared. The drier the food the greater difficulty it has in passing out of the stomach.

The feeding of horses has to be determined by the nature of their work; horses used for fast work should not be feed on bulky food; they should have more oats and less hay, for it is impossible for a horse to perform fast labor on a full stomach, because the pressure on the diaphram and the interference with the process of digestion will very likely cause disease. It is also certain that horses whose work is hard require nutritious food in small quantities, otherwise too great a time is required to abstract from it the necessary nutriment. Horses that have to work long hours with heavy pulling, such as plowing on a farm, have to be fed largely or they will not be able to stand their work, but this is done at the expense of the animal's health. In this case it would be better to feed the horse four times instead of three, and give less at a time. The fermentable nature of the horse's food shows the necessity of its being thoroughly masticated and properly mixed with saliva; the horse's inability to vomit warns us of the great danger to which the animal is exposed should derangement of the stomach occur; the extreme sympathy between the digestive organs, the skin, feet, nerves, lymphatic, and the urinary system, points to us how many diseases of quite a different nature may depend on the food given; broken wind, laminitis, diabetes, lymphangitis, paralysis, congestion of the brain, diarrhoea and a host of others.

Horses should not be worked until they are exhausted, or if they are, they should have food in small quantities, such as a few handfuls of bran and a little water. This will strengthen the stomach, and prevent bad results. Many cases of colic are caused by the ravenous manner in which horses that have fasted over their time swallow their food. A certain bulk is essential to the proper performance of digestion in the intestines, but it should be introduced

gradually; changes of food should be gradual. Horses when first put to grass should have some dry food or only a small quantity of green food for a few days until the stomach becomes accustomed to it, as a large feed of green food is very dangerous. The change should also be gradual when a horse is first taken from grass and put into the stable, as it is liable to suffer from swelling of the legs. It is necessary to curtail the food for a few days if the animal is going to stand in the stable, as this will prevent the diseases known as azoturia and lymphangitis, especially among the heavier breeds of horses.

Foods of a bad, course, musty or bulky nature are a common cause of that singular disease known as heaves; not that they have any direct action on the lungs, or that they fill up the air cells with dust as some suppose, but from their injurious effect on the nerves supplying the stomach, lungs and heart.

The formation and constitution of the horse affects very much its capacity for assimilating its food; thus animals with narrow chests, badly "cribbed up" and of a light mealy color are "bad doers;" they are very liable to be troubled with indigestion, and purge on the slighest provocation; they never look well and are known to horsemen as "washy;" they require to be carefully fed; new oats or hay should not be given them. All kinds of good food have been tried, but it seems to be impossible to keep such horses in good condition and get any work out of them. If they are worked hard and are stuffed with food they seem to be affected with indigestion and colic. It is said that a horse can live twenty-five days without food if it gets sufficient water; if no water be given, it will live barely eleven days.

THE COUNTRY GIRL.

BY MRS. H. M. DUNLAP.

What can I say, dear country girls, that will cause you to look within and about you, and make you study the conditions that surround you and also find the hidden powers that lie within your own being to make yourself and others happy? Happiness is the goal which all are striving to reach. How are we to attain it? Is it the acquiring of wealth, power and position that will bring it? Do we find those who possess these things our happiest people? No! They oftentimes are most miserable. A little secret must be learned first; that, be we rich or poor, high or low in life, happiness comes from within, and that "the most effectual way to secure happiness to ourselves is to confer it upon others."

So, if your lot is cast near to Nature's heart and you have the privilege of studying her in all her various forms, do not look upon your city sisters with envy and think that if you could only be in their position you would be happy. Do you see them always happy?

We find the majority of our country girls desiring to change country life for that of the town or city, and I wish I might help them to see that the change oftentimes brings only sorrow and disappointment, instead of the happiness they seek.

I know you think you lack opportunities and privileges in the country that are obtainable in the city, that life is different there from here, and that you could be better and make more of life if you were there and so "miss half of the good of life in discontent with your surroundings." It is a mistake to think these things will bring happiness, for as I have found it, and most of my life has been spent in the country, we who live in our country homes have much more to help us toward a happier and better life than those in our cities. Opportunities are always ours for improvement if we wish to seek and use them.

I wish that every girl, wherever may be her home, might feel

that the first step toward a true life is to find what powers lie within that will tend to make her a useful and helpful woman, and then go to work to develop them. Can she not do it in the country as well as, if not better than, in the city? The most practical life is often one of the greatest culture and refinement.

The growing tendency is toward a life outside of the home life for girls. They are seeking positions in stores as clerks, book-keepers, etc., in fact a business life, until we are beginning to wonder what is to become of our homes. Are you as girls as well fitted to assume home duties when all your education has been in another direction? When you find yourselves surrounded by home duties then, through ignorance of these essentials, life ofttimes becomes a drudgery.

To me the first duty of every girl or woman should be to educate and train her mind and heart towards a love of home and the science of home-making. That knowledge would be the foundation stone of a happy life. Whether in a home of your own or in the homes of others, such knowledge would be of paramount value to you. Some say all are not fitted to become housekeepers or home-makers; that they have a natural dislike for this work. I say all are not born mathematicians, scientists, linguists, etc., but all educated people have some knowledge of these subjects, so I know you can acquire some of this science, even if you cannot be an adept in it. I pray you, dear girl, never to enter a home as mistress of it and expect to make a happy dwelling place for its inmates until you are versed somewhat in the science of home-making.

We see many of our girls go through our high schools and colleges and soon after entering homes of their own, and while they are said to be educated, they are in fact ignorant of all knowledge that will help them to make a happy home. Education should mean a fitting and preparing for every day duties, that we may perform them in the best and most scientific way. Have we not desired in the past, or do we to-day, as women, desire to know the scientific way of performing our duties in the home? You know there is a right way and a wrong way of doing things. The scientific way is the right way, and I have found, since studying this science of the home, that there is a right way of doing the most simple tasks we have to perform, and it is our privilege and duty that we should know them.

Stop and think! Would you expect a carpenter to build a home without any knowledge of the tools and methods necessary to

accomplish the work? Would you expect a physician, lawyer or mechanic to do his work without any special preparation for it? Should not your position as women demand that you should have this knowledge of the scientific preparation of food, its nutritive value and use for man, sanitary care of the home and its surroundings, in fact, a knowledge of Household Economics, as a part and the most important part of your education? If we knew how to cook and prepare and use foods properly, there would not be need of so many physicians and we would possess healthy bodies, where now they are diseased and full of aches and pains.

Don't consider that this question is not worthy of your attention and that it does not amount to much, for it is one of the greatest and most important before us. We should know more of our bodies, their chemical composition and the food necessary to feed and keep them in repair, but, as it is now, our ignorance in this respect is appalling.

To you, girls, we look for a bettering of the present conditions. Many hearts and minds are becoming interested in devising means and opportunities for you to obtain this knowledge and I hope that an awakening may come to our girls that they may desire and improve these advantages. We hope to obtain from the Legislature this winter an appropriation for our State University, from which may be developed this line of education for our girls. The boys of our state have the opportunity of learning about shop practice, electrical and mechanical engineering, agriculture and horticulture, but our girls have not the opportunity of gaining knowledge of their special lines of work.

The Michigan Agricultural College has a Woman's Department and it gives a thoroughly practical course of study. "This course is four years in length and is crowned with the degree of Bachelor of Science." "The distinguishing feature of the woman's course is the department of Household Economy and Domestic Science." "During the junior and senior years students shall elect work in one of the following courses: Floriculture, fruit culture, kitchen gardening, millinery, dairying and poultry raising." An applicant will be admitted to the freshman class on the presentation of a diploma from an affiliated high school, or teacher's certificate, or by passing a creditable examination on the English branches. Hasten the day when the country girls of Illinois may have such an opportunity. You could enter such a course direct from your country schools.

More important are these things to you as girls than the acquiring

of mathematics, languages and many of the things you spend many hours of hard work upon and then never use when you find yourself the guardian and maker of a home. Don't understand me as not believing in the higher education of women, for indeed I do, but I believe we are leaving out the highest and best part of our education when Domestic Science and its attributes are not in our curriculum of studies.

Life is beautiful, dear girls, and I wish that I had the power to help you understand that you are to study those things which are essential as well as music, literature and art.

Make your lives pure, and true, and good, and expect the same in the young men who are your associates. Life is much as we make it and we build our characters and homes for ourselves in this life more than you may think; and so I beg you, train your mind, heart and hand in wisdom's ways of right and duty and your reward will be a life with much happiness intertwined with the vicissitudes that must come to all.

ON THE PRINCIPAL CORN INSECTS

And Methods of Controlling Them.

BY S. A. FORBES, STATE ENTOMOLOGIST AND PROFESSOR OF ZOOLOGY.

The corn plant is by far the most important plant in America, covering a greater part of our area than any other, and yielding a greater product both in quantity and in money value. Its remarkable adaptation to our soil and climate gives us little less than a monopoly of its production; and in a few of the central states of the Union, more corn is raised than in all the world beside.

Every consideration bearing on the prominence of this crop applies similarly, of course, to the insects affecting it. A species damaging corn but one per cent. would cause far greater loss than one which should destroy the entire barley crop of the state. A corn insect affects our agricultural interests nearly three times as much as one injuring wheat in the same ratio; more than four times as much as one injuring oats; about sixteen times as much as an apple species; twenty-eight times as much as a potato insect; one hundred and ninety-five times as much as one infesting broom-corn and sorghum; four hundred and eighty times as much as one attacking the peach, and nearly a thousand times as much as one infesting the grape.

The corn insects now recognized as in some way and to some extent injurious to some part of the plant number 214 species, of which 18 are known to infest the seed, 27 the root and the subterranean part of the stalk, 76 the stalk above ground, 118 the leaf, 19 the blossom—that is the tassel and the silk—42 the ear in the field, 2 the stacked fodder, and 24 the corn in store, either whole or ground. The greater part of this long list, which is doubtless by no means really complete, is composed of those whose injuries are now so slight or rare as to constitute a possible menace rather than to cause a serious loss; but the history of economic entomology, and even of the entomology of this one plant, teaches us that we can rarely tell in advance what to expect of any possibly injurious species. In fact, some of the insect enemies of corn now most destructive were not many years ago almost unknown even to the

entomologist--the northern corn root worm and the corn root aphis, for example.

The principal insect species infesting this plant are the seed-corn maggot and the wireworms, attacking the seed; these latter insects, the white grubs, the corn root worms and root aphis, affecting the roots; the cut-worms and root web-worms, the army worm, the stalk-borer, the corn worm, the bill bugs, the chinch bug, the corn flea beetle, and the grasshoppers, injuring stalk and leaf; the corn worm, the corn root worms, and the grass hoppers, eating the flower structures and the ear; and the meal-moth and the weevils devouring the kernel in the granary or the meal in the bin. Of these, by far the worst at present are the wire-worms, the corn root worms, the white grubs, the root lice, the cutworms, the chinch bug, the grasshoppers, and the army worm.

The various insects affecting corn may be most conveniently grouped for economic treatment according to the part of the plant which they infest. If the nature and the appearance of the injury inflicted be also taken into account, the most important species may usually be recognized without difficulty, even by an unskilled observer.

INJURIES TO THE SPROUTING KERNEL IN THE EARTH.

Insect injuries to the sprouting kernel in the earth are much more general than is commonly known, the failure of corn from this cause being very often attributed to unfavorable weather or defective seed. They are, indeed, somewhat influenced by weather conditions, becoming more serious as the corn germinates more slowly. They are usually due either to a very small yellowish ant one-twentieth of an inch in length, to two footless maggots, or to some one or more of at least six different sorts of wire worms.

The minute ant (*Fig.* 1) is rarely seen in cornfields, but its work may be recognized by the fine meal which it drags into the dirt as it hollows out the softened kernel.

The two maggots are both white; one, the black headed grass maggot, one-fourth of an inch in length, with a shining black head (*Fig.* 2), and the seed-corn maggot, one-fifth of an inch in length, with no head at all (*Fig.* 3), the first occuring in numbers only after grass, and the second without reference to the preceding crop.

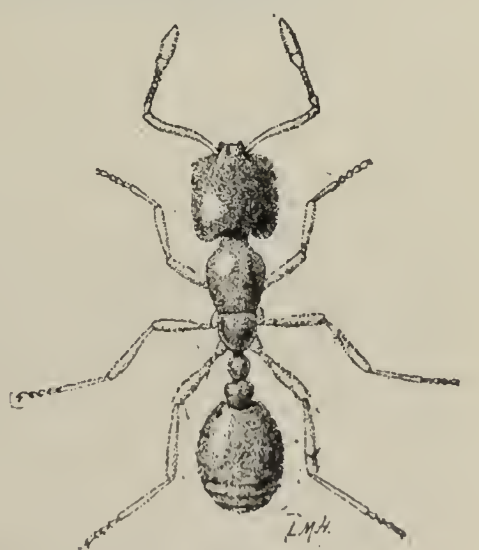


Fig. 1—*Worker.*

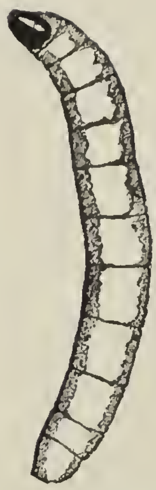


Fig. 2—The Black-headed Grass Maggot.

Fig. 3—The Seed-Corn Maggot.

The common species of wire worms infesting corn, perforating the kernels or boring through the stalk or larger roots, are so much alike in general appearance, habits and life history, that it is not easy or practically necessary to separate them. Their smooth, shining, hard, distinctly segmented bodies, and flattened head, the three pairs of short legs on their anterior segments, and the surprising strength and ease with which they wriggle out of the fingers, will distinguish them beyond mistake from any other insect affecting the seed (*Fig.* 4).

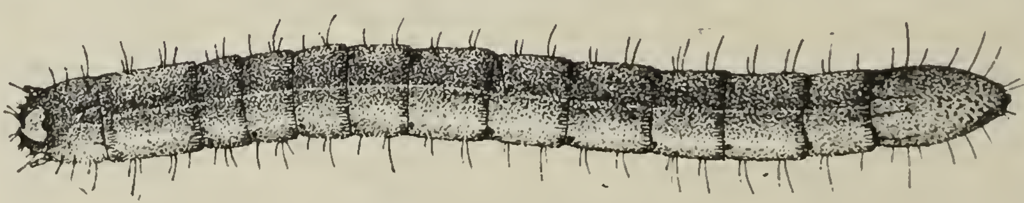


Fig. 4—The Corn Wireworm.

INJURIES TO THE ROOTS.

If, after making a start, the young corn stops growing, now and then a hill, or in patches, here and there, of variable size; or if, occasionally, stalks wither and die, we most frequently find that either the roots or the subterranean part of the stalks are suffering some insect injury. If the former, in the great majority of cases the damage has been done by one or more of three kinds of insects; the wireworms, already mentioned, the large white grubs, known to every one, or the corn root aphis.

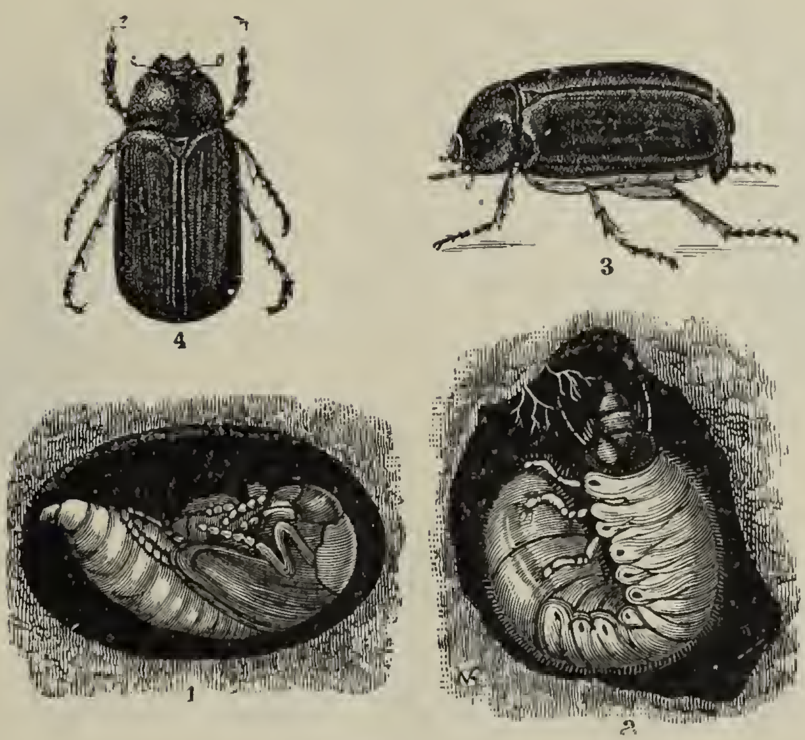


Fig. 5—*White Grub, Larva and Adult.*

That the common "white grubs"(*Fig.* 5) live in the earth a little over two years; that they devour the roots of a great variety of plants, including corn; that the full grown larvæ change to the adult and come out of the ground in May and June, and that these feed on the leaves of a considerable variety of trees, both of the forest and the orchard; that they pair in midsummer and lay their eggs in the ground, more commonly in grass—these are facts that have been so frequently rehearsed that few can remain unacquainted with them.

The corn root-louse (*Fig.* 6) is a minute, sluggish, pale bluish-green insect, seven-hundredths of an inch long when full grown, found adhering to the roots of young corn, from which it sucks the sap. It has as a constant companion in the fields, an abundant small brown ant (*Fig.* 7); and the presence of the louse may be inferred wherever these ants are found sinking their small burrows in or near the hills. The latter insects do no direct damage to the young corn, but are indirectly most injurious by the care and protection they afford the lice. According to our most recent observations, the ants preserve the eggs of the plant lice in their own winter nests, distribute the young as they hatch, to the roots of pigeon grass, smart weed and other weeds in the field; transfer them later to the roots of the corn as soon as this begins to start; and cherish them there throughout the spring. The lice in the meantime multiply freely and rapidly, part of a generation soon acquiring wings and flying abroad to stock adjacent fields.

Fig. 6—*Corn Root-Louse.*

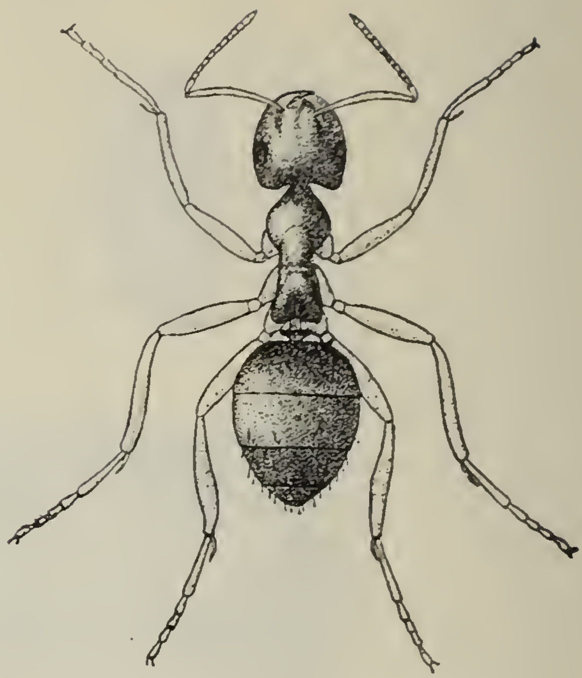


Fig. 7—*Small Brown Ant.*

Perhaps the worst of the corn insects at the present day is the corn root-worm (*Fig.* 8). Its presence first betrays itself in badly infested fields when the plant is a foot or so high, by a retardation or stoppage of the growth. Many of the larger roots are now short and stubbed and rotten at the ends; and on others a deadened brown track will be seen running lengthwise; and still others are quite dead the whole length. If the observer carefully split or peel some of the affected roots, a slender sinuous brown burrow filled with powdery excrement will be discovered running lengthwise of the root, and somewhere in its course the root-worm will frequently be found (*Fig.* 9). As the root dies, however, it is forsaken and another is attacked, until, not unfrequently, almost every root will become infested as fast as it puts forth. Later in the season, consequently, the hold of the plant upon the earth has become so weakened that the corn is easily prostrated by a storm, and even when full grown it may be readily pulled up. The

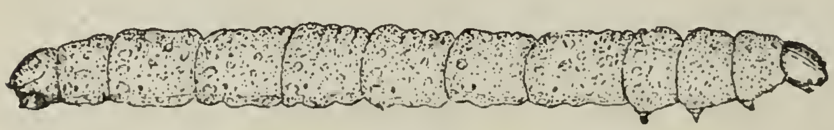


Fig. 8—*Corn Root-Worm.*

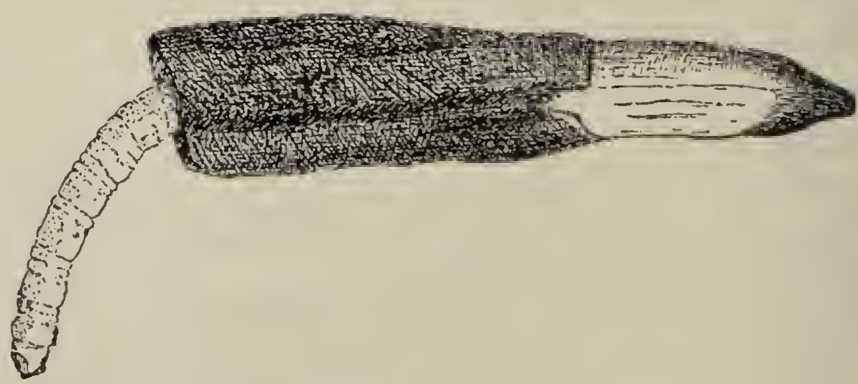


Fig. 9—*Corn Root Broken Across.* 6—*Show Root-worm Within.*

larva itself is as thick as a small pin, four-tenths of an inch in length, white, wrinkled, with three pairs of jointed legs in front, a brown head, a brown patch on the first segment behind the head, and a small brown patch on the back of the last segment of the body. It transforms in August and September into a grass-green beetle which feeds upon the pollen and silk of the corn and upon the pollen of other plants. *Fig.* 10.

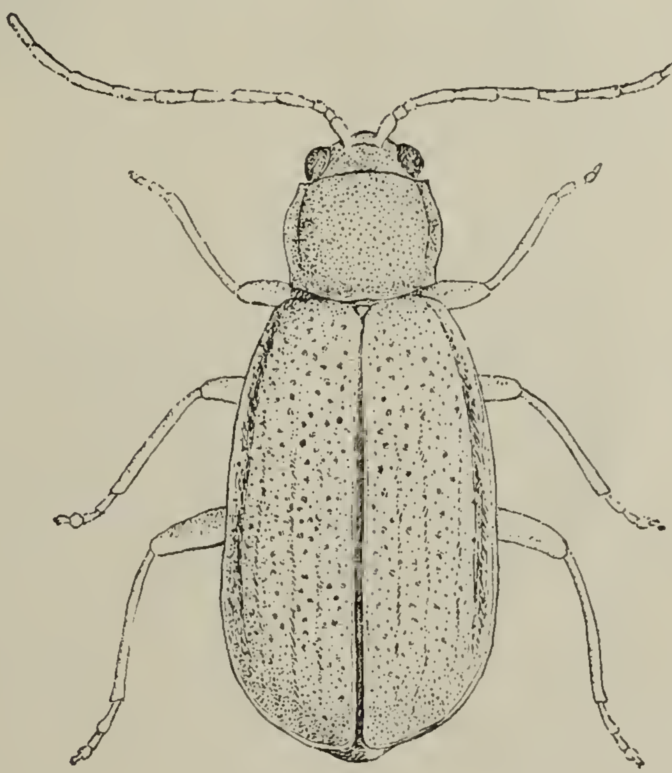


Fig. 10—*Adult of Corn Root-worm.*

INJURIES TO THE STALK.

The stalk of the corn may be injured under ground or above the surface. It may be bored from side to side, burrowed irregularly lengthwise, gnawed or excavated superficially, pierced with round holes by some sap-sucking insect, or cut away entirely; and, finally, it may be drained of sap through a multitude of minute insect beaks without visible injury to its substance.

Beneath the surface it is bored by wireworms when the kernel no longer affords them food, and is gnawed irregularly there, as well as above ground, by the root web-worms (*Figs.* 11 *and* 12)—small, reddish brown, slightly bristly caterpillars, with dark brown head, neck-shield and anal plate, and minute smooth brown patches on each segment of the body. These web worms also eat the leaves, beginning with the lowest, and irregularly gnawing them away. Their presence is easily demonstrated by a small mass of webbed

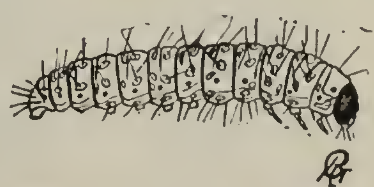


Fig. 11—*Root Web-Worm.*

earth in or beside the hill and within an inch of the surface. In this the worm makes its silken tubular retreat, where it passes the day, doing its mischief only at night. These web worms are grass insects originally, and vary greatly in the amount of their injuries to corn, according to their life history, all hibernating as caterpillars, but some transforming to the pupa in early spring, while others continue their attack until late June or early July.

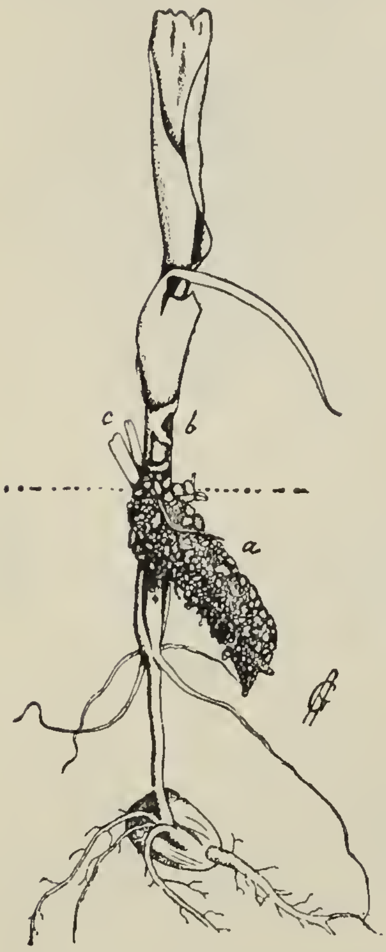


Fig. 12—Corn Plant.
Injured by root web-worm; *a*, tubular nest in the earth; *b*, gnawed surface of stalk; *c*, tip of severed leaf drawn into mouth of nest.

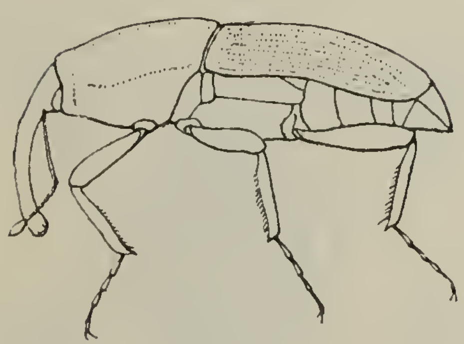
Under ground the earliest young chinch-bugs also work upon the stalk in spring, hatching from eggs laid there while the corn is very small, and the root lice, already mentioned, sometimes cover it in greenish clusters. Here also, the "corn-bill bugs" (*Figs.* 1 *and* 2, Plate) most generally operate, piercing the stalk with their strong curved snouts and feeding on its inner substance. The small circular holes thus made through the young leaves while these are rolled together around the stem, afterward enlarge and elongate with the growth of the plant, and mark the leaves with curious rows of regular oblong slits across the opened blade. These snout beetles are sometimes seen also above ground, upon the young stem.

The various cutworms (*Figs.* 3 *and* 4, Plate) are so well known to every one who has farming experience enough to plant a field of corn, that they need not be here discussed.

Other injuries to the stalk may be done by the stalk-borers, whose presence is indicated by a stunted, deformed, or withered plant, often with a round hole as large as a straw visible outwardly, or with the terminal leaves irregularly eaten at the base, where the worm has made its way inward. The caterpillars themselves are unmistakably distinguished by five white lines on the back and sides, those on the sides being interrupted near the front so as to leave a plain patch of the livid color of the general surface.

The chinch-bugs as they come up from the earth in spring, or as they make their way in from grain fields in summer, secrete themselves at first (if not too abundant) behind the ensheathing bases of the leaves and suck the sap from both leaf and stalk. Here

Fig. 1.



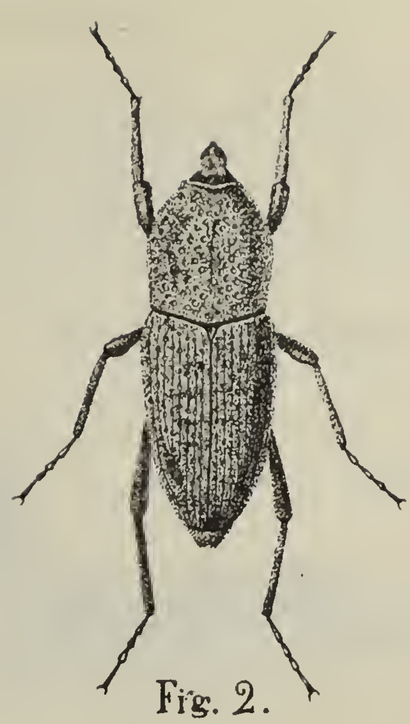
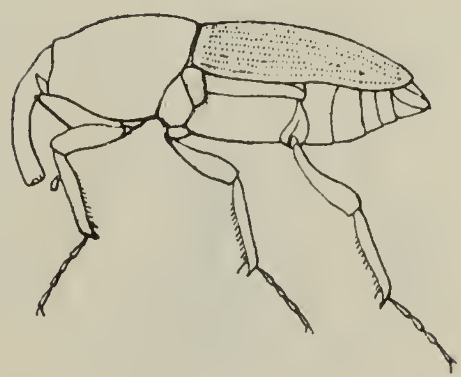


Fig. 2.



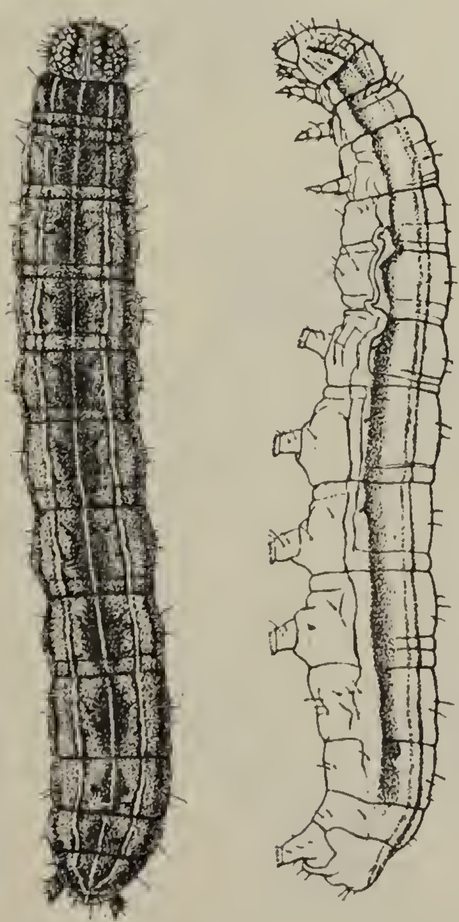


Fig. 3.

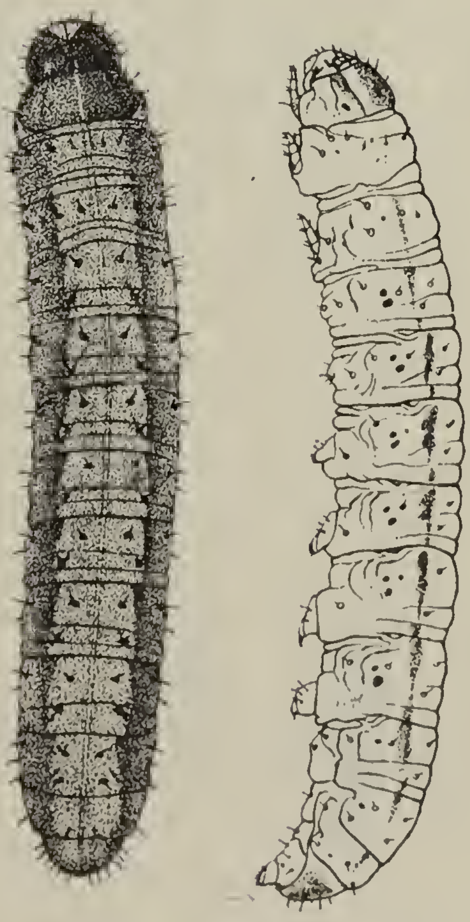


Fig. 4.

Corn Bill-Bugs and Cutworms.

the second brood develops, emerging to view when it becomes too numerous for its hiding place, or when the withering of the leaf and the hardening of the stalk compel it to seek more nutritious food.

INJURIES TO THE LEAF.

The worst injuries to the leaf are done by the chinch bug, the army worm (*Fig.* 13), and the grasshoppers, but the corn worm, the cut-worms, the root web worms, the stalk-borer, and the snout beetles also injure the leaves as an incident of their other operations. Besides these certain hairy caterpillars ("woolly bears") occasionally eat the leaf; the common rose beetle (*Fig.* 14) sometimes feeds upon the young blade; the small black or pale jumping beetles (flea beetles, *Fig.* 15) make holes in the leaves; other jumping insects, the leaf-hoppers (*Fig.* 16) suck the sap, dotting the surface with white specks where the cells have been drained and killed; and the corn leaf aphis (*Fig* 17)

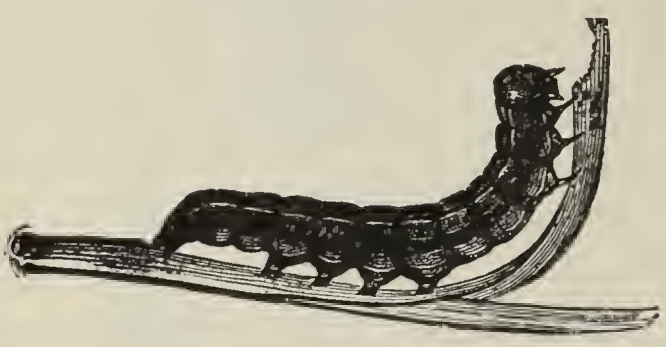


Fig. 13—*The Army Worm.*

Fig. 14—*The Rose Bettle.*

Fig. 15—*Flea Beetle.*

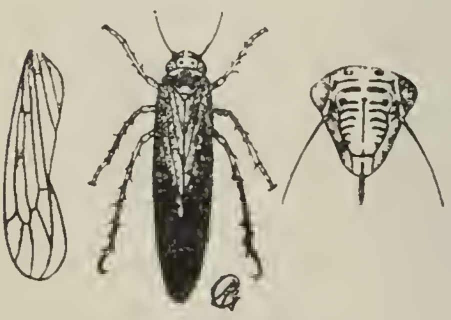


Fig. 16.—*Leaf-hopper.*

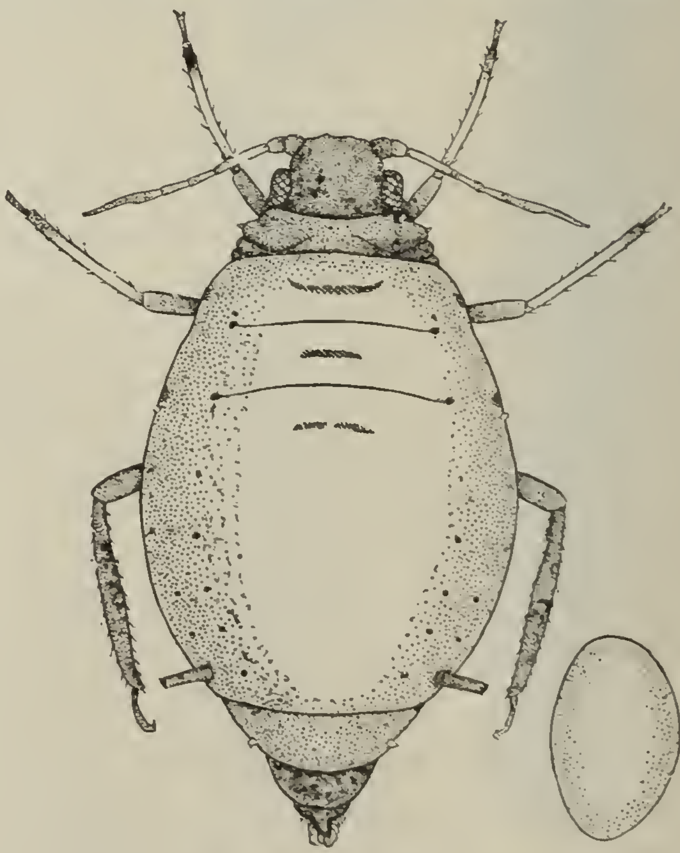


Fig. 17—*Corn Leaf Aphis.*

from July onward, often covers the upper leaves with its colonies.

INJURIES TO THE TASSEL AND THE SILK.

The young tassel and the fresh silk, the organs of fertilization, whose deficiency results in the blighting of the ear, are eaten away by the corn worm and the grasshoppers, and the silk also by the root worm beetle and the blister beetles. Possibly the sapping of the tassel by the multitudes of plant lice which often cover it may prevent the maturing of its pollen; but this I have not investigated.

INJURIES TO THE EAR IN THE FIELD.

The worst of the injuries to the ear on the stalk is done by the corn worm (*Fig.* 18), a peculiarly exasperating insect, as its depredations are not manifest until the work of raising the crop is done, and the farmers begin already to count it as so much cash in hand. It attacks corn in the ear, eating first the silk, and, as it increases in size, the kernels on the end of the ear while in the milk, and afterward working farther down, sometimes following the rows of kernels to the base of the ear, but more commoly burrowing about irregularly.

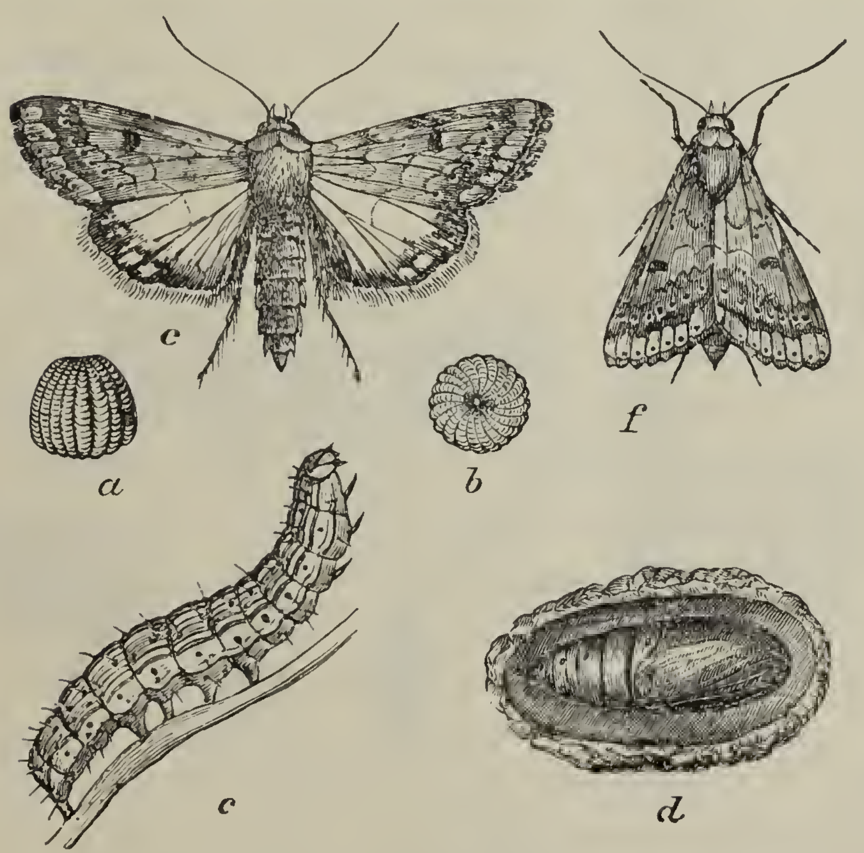


Fig. 18 – *The Corn Worm—moth, pupa, larva and eggs.*

This caterpillar is an inch and a half long when full grown and varies in color from pale green to dark brown, marked longitudinally with darker stripes of the same color, being somewhat lighter when young. There are eight round shining black spots on each segment of the body, from which arise short brown hairs. The head and neck are brown.

There are two broods of these worms, and perhaps three, at least in southern Illinois. The destructive brood comes from eggs laid in the silk when the ear is young. The caterpillars of this brood which reach maturity go into the ground and there change into pupæ in cells in the earth about five or six inches beneath the

surface, where they pass the winter, emerging as moths the following spring.

The common grasshoppers when very abundant occasionally do some damage by eating the ear in the field, although far less than by eating the silk while the corn is young. The tip of the ear is also sometimes infected by the root-worm beetle and the blister beetles (*Diabrotica longicornis and Epicauta vittata.*)

INJURIES TO STORED CORN AND MEAL.

The weevils (*Fig.* 19), red and black, the various grain moths (*Fig.* 20), meal worms, and meal moths, which infest corn in the crib and stored meal in the bin, are fairly well known to farmers in a general way. Although a great annoyance to grain dealers, they rarely give much trouble on the farm, where the cribs and granaries are commonly emptied every year and refilled with grain fresh from the stack or field.

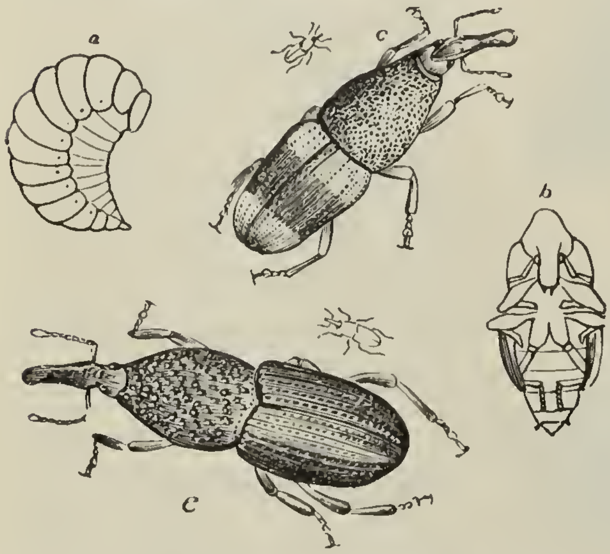


Fig. 19—*Grain Weevils.*

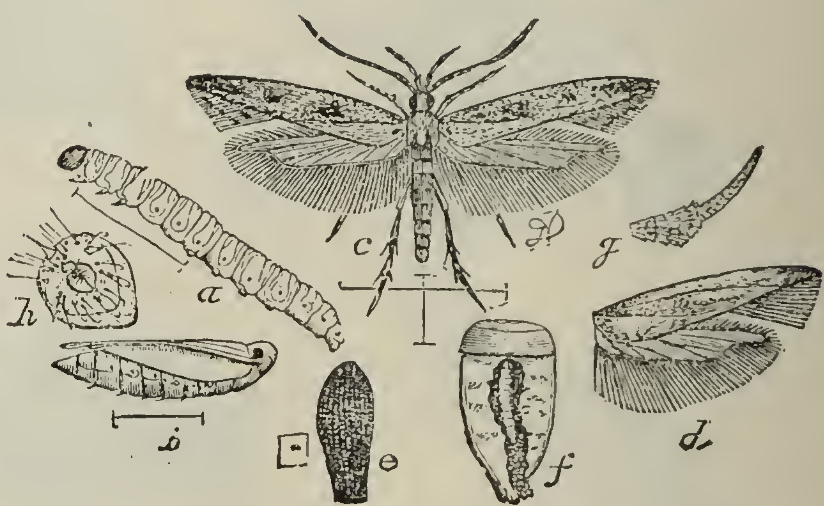


Fig. 20—*Grain Moth.*

PREVENTION AND REMEDY.

Preventive measures against insect injuries must be, as a rule, the main dependence of the corn farmer; remedies applied after the injury is apparent being almost invariably too slow of action or too expensive for economic use. It is fortunate that the general practices of an intelligent agriculture are themselves an important safeguard against unusual insect injuries, the insect hosts thus ever serving as a spur and stimulus to the use of improved agricultural methods, and especially to the pursuit of what is know as an intensive agriculture. Equally necessary is the habit of neighborhood coöperation, either through regular organizations or by informal conference and a general understanding. The most important measures against the corn insects must be taken by whole neighborhoods together to secure their best results. Many of the

precautions of the careful farmer may go for naught if his ignorant or indifferent neighbors permit the multiplication of a horde of insects sufficient to stock both their land and his.

Of special methods I place first a systematic rotation of crops, so arranged as to change not merely the crop but also to introduce into the routine at regular intervals some plants of a different botanical family, subject, consequently, to a different class of insect injuries from those most destructive to the cereal crops. Such a rotation might consist of corn, small grain, and clover in repeated succession, and at intervals varying according to the judgment of the farmer, with grass of all kinds omitted from this regular series. The permanent meadows and pastures, being thus outside this rotation for the cereal crops, could lie in grass as long as profitable and desirable. As they would, however, thus become in time mere breeding beds of all the root-feeding grass insects, it would be necessary that they should be broken up occasionally and planted to corn, but it would in such case be very important that clover or some similar plant, the cow-pea, for example, should be inserted before the corn, to stand for at least two successive years. This rotation would largely prevent the multiplication of cutworms, white grubs and wireworms in the earth, and would thus protect the corn crop in great measure from these worst of its continuous insect enemies.

One indispensable feature of any rotation including corn must be a careful limitation of the period in which the ground may be planted to that crop. Two or three years is the average length of time permissible, a longer period involving serious risk of injury by the corn root-worm or the corn root aphis. In any case where the grass-green beetle (the adult of the former species), is found abundant in the field in August and September, this should be taken as evidence that the crop is likely to be damaged the following year if the ground is planted again to corn. The eggs of this beetle are laid in fall in the earth of corn fields, and as the root-worms which hatch the following spring feed only upon corn, they necessarily perish if the ground is planted to some other crop.

Injury to corn by cut-worms when the crop is to follow grass may be largely, if not wholly, prevented by very early breaking of the sod the year preceding (the sooner after harvest the better) and by a such subsequent treatment of the ground as will kill and keep down grass and other vegetation until the middle or last of September. By this means the moths will be prevented from laying in the field the eggs from which the spring generation of cut-worms are to hatch.

The use of furrows and other barriers for the arrest of the movement of army worms is too well known to require special discussion. A modification of this time-honored measure has lately been proved highly advantageous in the midsummer contest with the chinch-bug. Its use for the latter purpose must vary, however, according to the weather when bugs which have been in small grain are escaping from those crops and making their way on foot to fields of corn adjoining. If the weather is very hot and very dry, the well known dusty furrow along the edge of the field, kept in good condition by dragging a heavy log back and forth from time to time, is all that is necessary. If the ground becomes damp with heavy dews or showers, post holes must be sunk at intervals in such a furrow to collect the escaping chinch-bugs, where they can be killed by sprinkling with kerosene.

If the ground becomes too wet for the furrow method, a zigzag line of coal-tar poured from the nozzle of a sprinkling pot must be substituted for the furrow, with post holes or cans or jars sunk in the angles of the line to trap the bugs as they pass up and down in search of means of escape. If the bugs get access to the outer rows of a field of corn, they must be killed by using kerosene emulsion diluted to contain about five per cent. of kerosene.

FARMERS' INSTITUTES.

Recognizing the value and importance of Farmers' Institutes, we present here the views of some of the most prominent institute workers of the state upon this subject. The old institute system has been found to be unsuccessful, and there are a number of bills in the State Legislature at present, providing for the re-arrangement of the institute system. We sincerely hope that some satisfactory method of conducting the institutes may be agreed upon, and it is in the hope of throwing some light upon the different modes of institute management that we have obtained the ideas as given below.

BY A. J. LOVEJOY,
President Winnebago County Farmers' Institute, Roscoe, Ill.

From a limited experience in attending various County Farmers' Institutes in Illinois, I have come to the conclusion that there has been more real progress in agriculture resulting from the Institutes since their organization, than from any and all other sources. The farmer that fails to avail himself of the benefit derived from a two days' attendance at his County Institute, simply misses a grand opportunity to improve himself by hearing good, sensible, every-day talks and discussions on the various methods of growing crops, improving his soil, breeding and feeding animals, and the many other subjects discussed.

There is usually a good attendance of leading farmers, yet many that should attend are the very ones that do not. These, no doubt, think they already "know how to farm" and are too wise to learn anything new. At most of our County Institutes there is a scarcity of the young farmers, a thing to be regretted. How to get these young men out and get them to talking and asking questions, is what must be the aim. Just how it can be done is more than I am able to say.

As to the best mode of conducting our County Institutes, it is

a question not yet settled, whether it be by a system with a central head, such as is proposed by the "Press Bill," making the State University the recognized head of the Institutes of the State, while the County still arranges the program, or whether the present plan of each County running its own Institute independent of any one. If the appropriation was made $100 for each County, instead of $50, it would be much better.

I am strictly opposed to an appropriation for a State Farmers' Institute, as proposed by certain persons now trying to get such a bill through the Legislature, with offices at Springfield, who have posed before the country as a State Farmers' Institute for the past two years. I have never been able to learn of any earthly use this association has been to the County Institutes.

I think the interest in Institutes is growing each year and will continue to do so in years to come. Any plan that can further the interests of the farmers of Illinois will be welcomed by the majority of those who know the great value of such Institutes.

BY C. A. SHAMEL.
Managing Editor of Orange Judd Farmer.

Farmers' Institutes of Illinois can only be made completely successful by organizing them into a system and placing this system under the direction of some competent bureau, which shall act with existing Institute organizations in presenting programs and creating Institute societies in localities where they do not now exist. The Agricultural College of the University of Illinois, as the logical head of the agricultural educational system in the State, should control this bureau. It would then be possible to hold Institutes in adjoining counties in succession at a comparatively small expense, employ competent speakers and annually present a good Institute in every County of the State. This is impossible under the present condition of affairs. True, a number of first-class Institutes are held each year and there are some very strong Institute societies where live meetings are the rule and much good is done. These, however, are confined to certain localities of the State, and those sections which most need education along these lines are neglected.

The Institute Association, created by an act of the last Legislature, in my opinion will never be of any particular value, as it is so unwieldly that it cannot be used to advantage. It has been in operation two years and has resulted in but little good. It has no

authority for fixing dates or assisting in programs, or in securing an Institute for every county.

BY H. AUGUSTINE,
President Central Illinois Horticultural Society, Normal, Ill.

I believe the State is right in making the appropriation of $50 to each county holding an Institute, but with the present arrangement any irresponsible party can start out and hold an Institute and draw the money if he complies with the law, and thus it is liable to fall into the hands of inexperienced persons and then the better class of people don't feel like falling in line. I believe that the Illinois Farmer's Institute, as organized more than a year ago, is an improvement on the old plan still in vogue in a large part of the State, but even this new organization in my judgment should be under the direction of thoroughly responsible men and have its headquarters at the University of Illinois and under its management, and that the Institutes throughout the State should be held in such rotation as to enable well informed, capable men on all different subjects to be discussed to attend this with as light expense as possible, and to do this the Institute ought to go somewhat in order so as to avoid the waste of time and expense of travelling great distances. In my judgment there is no other channel through which the farmers can receive the amount of information and help from capable men, as cheaply and as nicely as through the Farmers' Institutes, and the organization ought to be put in the very best possible shape. I hope this matter may be pushed until we have thorough organization all over the State of Illinois.

BY MRS. L. G. CHAPMAN,
State Organizer of Granges, Freedom, Ill.

The interests of men and women on the farm are so nearly identical, and their business is so dovetailed that it is impossible to disconnect the one from the other, and it is but natural that they should work side by side. If so on the farm, why not in a Farmer's Institute? What is a Farmer's Institute? "An institute is a literary or philosophical society or school of instruction." It should be a school of instruction in which the different branches of husbandry are taught by specialists.

The object the promoters had in view when Farmers' Institutes were organized, was to educate the the farmers scientifically in their business, and to place in their way opportunities for conferring together that better methods of work might be evolved and agricul-

ture thus be placed on a higher and broader plane. If this is true for the farmer, it is equally true for his life partner, and each should be interested in what benefits the other.

I have thought of this plan to interest both men and women in the Farmer's Institute: At the organization or annual election, if there is a woman who can demonstrate her capability to hold an office and who is willing to undertake the work, elect her as one of the officers, either Secretary, Treasurer, or a member of the Executive Committee. This will show on the face of it that the Institute is organized for the mutual benefit of the men and women. If women are not recognized among the officers they may look upon it as they would on a meeting of the Board of Supervisors, and take no interest in it. Women could be appointed on any committee excepting the Committee of Legislation.

The program should be made up of both men and women, using as much home talent among the women as is available, so as to create a home interest. Poultry, butter making, flower culture, home management, and household economy or scientific cookery, could be assigned to the women. If a specialist could be found to take the last named topic, it would add much to the interest and also to the value of the program.

If this plan were followed much latent talent would be developed among the women of the farm, interest stimulated, and women would be as anxious for the success of the Institute as the men. Enlist the young ladies in the enterprise, for they are the magnetic force that will draw the young men. Upon these young shoulders rests the weight and responsibility of sustaining the future homes, the schools, the churches, and the government of this republic.

BY FRED GRUNDY. Morrisonville. Ill.

It might be a good plan to have a Board of Managers composed of three practical, progressive, up-to-date farmers, one each from the Northern, Central and Southern divisions of the State, to have general supervision of Farmers' Institutes. This board could appoint a thoroughly efficient secretary, and at the proper time meet and arrange dates for all of the Institutes in the State, so there would be no clashing. They could also select an expert to deliver an address on some subject the farmers in each locality are most interested in. In one county it would be fruit growing, in another dairying, in another stock raising, etc. The expert selected

to instruct the farmers in these matters should be a man who is known to be eminently successful in his particular line.

The management of the details of each Institute might properly be left to its officers, but it would be a good idea for each member of the Board to attend every Institute in his division, and suggest such changes in the management as he might deem advisable.

By having the dates properly arranged, and a manager in each division, it would be possible to have all the Institutes held at a time when farmers could attend them without difficulty. If Institutes are made thoroughly good and instructive the farmers will attend them.

BY MILLER PURVIS.

Agricultural Editor of Farmers' Voice.

It seems to me that the logical head of the Institute system of Illinois is the Agricultural Department of the University. The Experiment Station is there and questions that come up at the Institutes can be worked out there to a better advantage than at any other place, and the farmers of the State learn through the publication of bulletins what the results have been.

A Farmer's Institute is nothing it it is not a school at which information along the lines taught in the University is furnished, and it is but right and proper that those who make a business of teaching the most progressive system of agriculture should have the guidance of the wider work of the Institute. The problems that are worked out in the class work at the University would serve as a basis for the Institute work of the State and would round out the duties of the professors of the agricultural department into a symmetrical whole. They, having the work constantly in mind, would be better able to do it systematically and economically than almost any other body of men who might be placed at the head of it. Having evely facility for forwarding the work that is most needed at the Institutes, they would be able to give an impetus to the Institute system of this State that would place it ahead of that of any other state in the Union. We should avoid, above all other things, having the Institute work left to politicians and place hunters whose only interest is in drawing the salary attached to the office they hold.

BY E. E. CHESTER.

Vice President State Board of Agriculture, Champaign, Ill.

Farmers' Institutes, while usually attended by men and women in the advanced classes of agricultural investigation, are of value to

all the farmers where they are held. The State of Illinois owes much of its advancement to the fact that better methods are contagious, and when they get into a community they are apt to "go around." Unfortunately, however, some people are affected less than others.

Farmers' Institutes were, for a number of years, held at the University and under its direction; afterwards under the auspices of the State Board of Agriculture, one in each Congressional District, at the expense of the town or city where the same was held; still later under the direction of our Institute Board in each county of the State, and the expense was met by an appropriation by the State of $50 to each county holding an Institute. From a business standpoint the State has had an abundant harvest for the seed sown in the increased amount of taxable property.

In addition to the present County Board, and the appropriation of $50 to each county holding an Institute, there should be a superintendent whose business should be to make dates, assign speakers and subjects appropriate to their location and to the special productions of the locality. He should report to a board, consisting of the President of the University of Illinois, the heads of the Agricultural, Horticultural and Veterinary Departments of the same. This Board should be held responsible to the State for the high character and educational value of each and every program; the local board for expenses other than those of superintendent and speakers furnished from the University, and for local interest and attendance.

If the University is the fountain head of advanced thought and practice in industrial edncation, it should be put in a position to give the greatest number of people the advantage of its investigations.

HORTICULTURE IN NOVA SCOTIA.

BY J. C. BLAIR, ASSISTANT HORTICULTURIST

Nova Scotia is essentially a horticultural country. Extending out into the Atlantic Ocean and connected with the mainland by the Isthmus of Chiegnecto, a strip of land fourteen miles wide, and washed by the waters of the Gulf stream on the south and east, the Bay of Fundy on the west, and the Northumberland Strait on the north, she has a climate excelled for equability by few other countries. The thermometer seldom registers below zero in winter or above 82 degrees in summer. It is situated between 43 and 46 degrees north latitude and from 60 to 66 degrees longitude west of Greenwich. The northern boundary of Illinois extended 1,200 east would fall just south of Nova Scotia.

But it is the character of the soil perhaps as much as the climatic conditions that makes this province peculiarly adapted to the growing of fruit. Mr. S. D. Willard, a large fruit grower of Geneva, New York, and Vice President of the Western New York Horticultural society, after visiting the province, said: "I had no idea of the possibilities of Nova Scotia as a fruit region. The difference in growth made by plants in the soil of Nova Scotia and that of western New York is surprising. The same variety of plums there will generally have four times the growth upon the young tree that it will with us. This doubtless is the result of the difference in soils. Ours is rather a cold clay that makes growth slow and hard, thus delaying the maturity of the wood." Indeed many other visitors to the province have made similar remarks in regard to the peculiar fitness of the soil for fruit growing. It is therefore only when we understand these climatic and soil conditions that we are willing to credit the assertion with which this paper opens; namely, that Nova Scotia is essentially a horticultural country.

In area Nova Scotia is a little less than one-half the size of Illinois, having an extent of 21,000 miles. It is about 340 miles long and has an extreme width of eighty-five miles. The principal fruit region

is known as the Annapolis Valley, a level tract of land consisting of sand, sandy and clay loam, based on a sandstone formation. It is six to seven miles wide and 100 miles long, and lies in the western portion of the province. Protected from the north and west winds by the North Mountains, which lie close to the Bay of Fundy, and the South Mountains on the opposite side, this valley is still further insured from the sudden climatic changes so detrimental to the growth and welfare of fruit trees. It is in this region that the apple reaches its greatest perfection and where over a hundred varieties of small fruits and berries flourish wild and ofttimes in great abundance. The northeastern part of this region, especially in the vicinity of Grand Pre, has been immortalized by Longfellow in his poem of "Evangeline." In fact nearly the entire region has been made familiar through history by the expulsion of the Acadian French during the middle of the last century. Although the French paved the way for the later settlers, many of whom came from Connecticut and other parts of New England in 1760, much of the land has been brought under cultivation since that time. This valley contains about 250,000 acres capable of producing fruit of the finest quality, exclusive of considerable marsh land at either extremity that has been reclaimed from the sea by dikes.

But this is not the only fruit producing region in the province; although it must be admitted that it is the best, as well as the most extensive. In every county of Nova Scotia apples, plums and other fruits are produced in favorable localities in great abundance. Bordering the coast, where the salt breezes are daily felt, apples do not succeed well, but small fruits, cherries and plums attain a high degree of excellence.

Compared with the other fruit producing regions of the North American continent we cannot say that fruit growing in Nova Scotia is still in its infancy; nor can we say that it has reached that degree of perfection found in several fruit regions of the United States, at least in some respects. It may be said, however, that the most healthy and longest lived trees on the continent are probably found in Nova Scotia. Many orchards contain apple trees, which bear an annual crop, that are over one hundred years old. For nearly a century the cherry region of Bear River Valley, in the extreme southwestern portion of the province, has been famous. It may be well for us, therefore, to consider the horticulture of the province more in detail.

The apple is unquestionably the most important fruit raised in

Nova Scotia. The climate is especially favorable to the high development of flavor and color. Prof. L. H. Bailey, lecturing on apple growing at Ithaca, N. Y., said: "Nowhere in the world are better apples grown than in Nova Scotia. They are highly colored and splendid keepers." Prof. William Saunders, author of "Insects Injurious to Fruit," and Director of Experimental Farms at Ottawa, Ont., says: "I know of no locality where apple trees bear so abundantly and continuously as in the favored Annapolis Valley." The total apple crop for the province for the year 1895 was 300,000 barrels, most of which was sent to the English market. That of 1896 exceeded 500,000 barrels, which also largely found its way across the Atlantic, and netted an average price to the producer of one dollar per barrel clear of all expense.

Considering individual orchards and trees we are brought face to face with the fact that probably no other horticultural region reaps such large returns for labor and money expended. Many instances in support of this assertion could be cited from the reports of the Fruit Growers' Association. One of ten instances quoted in a report on "Profits and Cost of Fruit Growing in Nova Scotia," edited by the Secretary of the Nova Scotia Fruit Growers' Association, that of R. Harris, is as follows: Mr. Harris planted eighteen acres of orchard in 1857, setting out 900 trees. The first cost of the land was $1,800. During the last ten years the orchard has produced a total of 5,500 barrels of apples, the net amount of sales of which amounted to $12,875. The cost of cultivation during the same period was $4,200; the value of the crop, besides apples, $4,000; the net profits, $12,675. The present value of the orchard is $9,000, for which figure it recently sold. Comparing the figures of the ten above mentioned instances we find that an orchard of 1,000 trees gives from the tenth to the fifteenth year an income of $1,000 per year, and for thirty years thereafter $2,000 a year income, being the yearly income of an investment of $40,000 at 5 per cent. This, based on the low average yield of two barrels per tree and $1 per barrel net value. Dr. H. Chipman, of Grand Pre, addressing the Fruit Growers' Association at its twenty-second annual meeting, said: "In my own locality, within a radius of a little more than a mile from Grand Pre, thirty orchards produced 4,000 barrels of apples this season. In many different orchards Gravenstein and Baldwin trees produced fourteen barrels of marketable fruit each. Ten Gravenstein trees in Leander Rand's orchard produced 120 barrels of marketable fruit." These figures are certainly surprising,

and considering the longevity of the apple tree, serve to show us the magnitude of apple growing alone in the province.

Plums will probably rank next in importance and extent of cultivation. They are grown successfully in all parts of the country, and in none more successfully than in the eastern counties and bordering the Northumberland Strait. The trees usually come into bearing the third year, and yield thereafter one-half to four bushels per tree annually. Mr. F. F. Mitchell, of Grand Pre, raised from one Weaver plum tree, the fourth year after planting, two and one-quarter bushels of fruit, and sold them for $10.69. Based on the actual experience of several growers in the province, the total revenue in ten years, from a plum orchard of ten acres, is not less than $29,000.

The pear, peach, cherry, apricot and quince are grown successfully in many counties of the province. Of the pear, the Bartlett and Clapp's Favorite seem to be the leading varieties. They make a vigorous growth and are very productive. Peaches, however, are not grown on a commercial scale. They do extremely well in the Annapolis Valley, but do not flourish in other sections. The Alexander is considered the best variety. Cherries are scattered all over the province, but the one distinctive cherry region is that of Bear River Valley, which has already been referred to. Apricots attain perfection in many sections, but fungous diseases retard their cultivation here. Quince trees, especially the old Orange variety, do well in the more favored regions. Some trees of this variety that are over fifty years old exist in the Annapolis Valley. The great interest in apple culture, and the fact that the Ontario quince controls the Canadian market, has been against the growing of this fruit on a large scale.

Grapes are not grown in Nova Scotia to any great extent; and yet we find some varieties doing exceedingly well in some of the northern counties of the province. Aside from a sufficient quantity for individual consumption the Nova Scotia grower will probably rest content to allow the peculiarly adapted grape regions to furnish their markets with this luscious fruit.

The subject of small fruits will be but briefly treated; for as already stated, many varieties flourish wild in the province. First in excellency, profit and extent of cultivation comes the strawberry. In the reports of the Fruit Growers' association several instances are cited where 8,000 quarts of this fruit have been produced from a single acre. The profits accruing from the cultivation of the

strawberry range from one to three hundred dollars per year per acre. Much of this fruit finds its way via steamer to Boston and New York markets.

Raspberries, blackberries, currants and gooseberries find a conspicuous place on nearly every homestead in the province. Cranberry culture is assuming commercial importance in many of the swampy districts. One hundred barrels of marketable fruit to the acre is gathered annually, and sometimes much more than that amount. These bring from $3.00 to $7.00 per barrel net profit. Mr. Henry Shaw, of Berwick, N. S., says: "I got 108 barrels of this fruit per acre and sold them for $7.34 per barrel, which gives $600 net, or a profit of $600 per acre."

In regard to vegetable growing, little need be said. Nearly all varieties of garden vegetables are found flourishing throughout Nova Scotia. The potato crop, however, is the principal in point of excellence and extent of cultivation. Much of this is exported to the Bermuda Islands for seed.

Before considering the educational advantages offered in a horticultural way, we should note here that the fruit growers of Nova Scotia are not exempt from the insect depredations and diseases common to most fruit regions. The most serious of these are the canker worm, oyster shell bark louse, the codling moth, and the diseases known as canker (which is similar to pear blight) and black rot.

One unique feature of the horticulture of Nova Scotia, and one that cannot fail to impress itself upon our minds, is the fact that the only purely horticultural school on the continent is situated in the Annapolis Valley, in the town of Wolfville. This school is well equipped for the teaching of all the phases of horticulture, both theoretical and practical; and under the direction of Prof. E. E. Faville, a graduate of the Iowa Agricultural College, is doing much to interest the youth of the province in this branch of work for which their country seems so well adapted by nature. At the Provincial Agricultural College at Truro the different phases of horticulture are also given due consideration by Professor Smith, who is a native of New York State and a graduate of Cornell University. Horticultural interests at the Maritime Experimental Farm at Nappan, N. S., which is a branch of the Dominion system of experimental farms, are under the immediate direction of Horticulturist W. S. Blair. Nearly all the varieties of fruits and other horticultural plants are tested at this station. These three institutions,

working together in the interests of horticulture and agriculture, together with the Fruit Growers' Association and other organizations, are doing much to popularize an advance of the farmer's calling.

Having discussed in the foregoing pages the horticultural features of the province, let us in conclusion briefly consider some of the natural advantages, aside from those of soil and climate, that have contributed to the development of the fruit industry of Nova Scotia. The foremost of these natural advantages, and one not possessed to a like degree by other fruit districts, is the numerous good harbors at easily accessible points along the sea coast, no part of the province being over forty miles from a good shipping place. Another advantage is the nearness to the great markets of Europe; and still another is the cheapness of transportation not granted to those regions wholly dependent upon railway carriage. Taking all these facts into consideration, together with what she has accomplished in the past, we may look forward for even greater things in a horticultural way by Nova Scotia in the future.

WHAT SHALL HE DO?

BY E. DAVENPORT, DEAN OF THE COLLEGE OF AGRICULTURE AND DIRECTOR OF EXPERIMENT STATION.

Early in the life of every ambitious young man there comes a time when he seriously considers what he will do with himself, with the life and the possibilities of which he finds himself possessed. Fortunate is he who chooses once for all wisely and well, and most unfortunate he who never decides but drifts along, the sport of circumstances and the play of fate.

Much depends upon this decision, not only to the man himself but to his descendants that shall come after him. He is in a great measure deciding the future of his family, or the branch of it which he represents, and he has no right to decide hastily or according to prejudice or caprice.

To all this the young man on the farm is no exception. All the difficulties and doubts that beset young men incident to this question will come to him to disturb his faculties and to make his decision difficult, and this is written by special request in the hope of assisting the young land owner in this first serious business of life.

Let me be understood. I am speaking now to young men who own land, or who belong to families that possess landed property, which is the same thing. Of these, so many as certainly possess a decided taste for a particular calling, let them by all means follow that calliing, for all honorable professions must be sustained and they must be mostly recruited from material not many generations removed from the land. But if one abandons the land let him do it for valid and positive reasons, and before he does it let him consider carefully all that is to be lost as well as what is to be gained.

All professions but those of the farm and the mine are more or less closely connected with the city. Of these he hears and reads much, but specifically of the success of a few remarkable men. He does not hear of the purgatory of days and weeks, and years of

PROF. E. DAVENPORT.

weary labor exhausting almost to discouragement, that most of these same men endured before success finally came. Of the final failure of many of them he does not hear, nor of the wrecked hopes of the multitude that never enjoyed even a brief space of prosperity in the intense struggle for existence that characterizes all professions and that is destined to grow yet more bitter, more exacting, and more merciless.

Of the hard labor upon land he is fully cognizant. It is almost the only business which little children see in full operation and in a way that they can understand and can take part in; and in that fact lies the superior advantage of the boy that is country born. He has seen more enterprises carried through from start to finish, accumulated more experience and tested his powers to a higher degree than is possible with his city cousin, although in the learning of the schools he may be less adept, and in the language of the hour, less fluent.

We have not yet passed the age of hero worship and all the great men of the ages have been almost cannonized, and they have passed into books together with all that they did, and perhaps some things that they did not do. There seem to be many of them, and we like to believe that to the ambitious all things are possible. It is well to be hopeful and to be courageous, but it is also prudent to be sensible. For great success there must come together the opportunity and the man. These men are culled from ages of human history. The opportunity is not frequent, and when it arises it needs a man trained by long hardship for that particular work, and what is peculiar in the matter is the fact that most great men have been discovered like new continents, and had not been in preparation for that particular and unforseen emergency, but were, like good citizens, attending to the ordinary affairs of life, and not a few of them were upon farms.

We have so dressed the names and the deeds of our great men with the utmost skill of poetry and of oratory, that we have not only covered up their own long and hard years of preparation, but we have made the success of ordinary people, which is really extraordinary, seem commonplace and mean, and below the ambition of a spirited young man.

I would say nothing to check enthusiasm or to belittle greatness. I would rather exalt greatness by holding it in its true light as most difficult of attainment. I would sharply call attention to the unnumbered thousands who have died unsung, yet who have

each succeeded in his way and left his impression upon the world for good. I would emphasize to this young man how really honorable and difficult is the degree of success attained by the best citizens all about him. I would assure him that if he be truly born for a great man he will give unmistakable evidence of his greatness by attaining eminence in something by the hard process of labor; that the world will surely find him out, no matter what his occupation; that the occupation makes less difference than the method of its following, and that a man is nowhere so much alone, nor his identity so absolutely lost, as in a great city, unless he be there for a definite purpose.

All this is said because books written for the encouragement of the young speak almost exclusively of exceptional success and of men and conditions not commonly encountered. They do good in that they arouse the spirit of emulation; they do harm in that they make the exceptional seem common and set up a standard that is for the most part impossible of realization, and the reaction upon the disappointed young men is disastrous; they do harm in that they make success seem to be the necessary consequent of enthusiastic volition rather than the result of that persistent hard labor of a man of inherent capacity combined with most fortuitious circumstances. It is well if he know at the outset what most men learn by experience, that a reasonable degree of success is most difficult of accomplishment, and that, as in military matters, to command one must first learn to obey, so, to be able to use the opportunity when it comes, a man must gain experience and fortitude by hard and persistent labor. He cannot look lightly upon ordinary success and hope to be entrusted with the great things of earth, but must prove himself at every step.

But aside from all questions of sentiment or lurking hope of fame every right minded young man desires to make the most of himself and the opportunities of his day, and that is right. To put that desire into definite shape and make it into action leading to results, is what he needs, and it is at the outset of his attempt in this direction that he most needs light and help.

Nearly all ambitious young men desire a good degree of education, and no great class of people educate their children so well as does the American farmer. There is no reason why he should not have an education, and there is every reason why he should. If he occupies land it can educate him, for a good farm can educate every generation that is born upon it. A college course now costs nothing

but personal living expenses, books and hard work, and I say it advisedly, every young man of the next generation will need it, and especially can the land owner profit by it. The years of his college course will give him touch with the great busy, thinking world, both past and present, and will put him in position to come into relations with that which is just ahead. So let him, by all means, decide to be educated, and that, too, in the best of schools. The colleges of agriculture have carefully studied the problem of the higher education of our landed population and the semi-technical courses they offer, while not lacking in scientific training nor in mental culture, take special note of his business interests.

A good many young men, especially in the country, are possessed of a desire to "see the world," and this thing is a great disturber of their peace. There is much of the world that is best not seen, and if he sets out with the express purpose of seeing the world it is that portion which will first present itself, and after he has spent more money and time than would suffice for a college education, he will know less of the real world than his instincts would have taught him before he started.

If a faithful student at a good college, he will form a most intimate acquaintance with the world as it exists for power, for progress and for the general good. He will come into contact with the best young men and women of his age, with a safe class of leaders in his instructors, and with the world's best men in books. Then he will have seen most of the world that is worth seeing, except as he will look with the eye of a traveler upon certain natural, racial or economic problems, whose very existence is unsuspected by him who starts out to see the world by main strength.

But in the way of business this simple question must ultimately be met: Shall he remain with the land, or fit himself for a city business or profession?

So unprecedented has been the productive energy of our people operating upon a virgin soil and in undeveloped mines; so vast the resulting business and so frequent the amassing of wealth, as if by magic, through fortunate investment often of insignificant capital, that men have confused the terms speculation and business. The days of successful speculation upon small capital are about over, and if a man thinks of realizing in cash upon his landed interest, be it much or little, in order to start himself in business he will almost surely but add one more to the countless numbers who have learned too late that, however it may have been a generation ago,

we have now enough capital in this country seeking investment to develop anything likely to prove profitable, and that it is powerful enough and cruel enough to ruin any small speculator who happens to be caught in its way. This is only another way of saying that from now on every man may expect to make his way, if he make it at all, by the slow and conservative methods of business that always obtain in an old country, and that if the man in question thinks to cut loose from land he had best leave it behind intact in case he should change his mind, for it is the common experience that when a family once abandons land it is rarely able to again obtain possession.

Nothing is more natural or more proper than that the young man should measure the income of his father's farm over against that of a city profession, or the salary of a business employe. In this comparison the farm always suffers, because the income from city occupations is a gross amount from which must be deducted living expenses at a high rate, while the income from the farm, as he knows it, is a net amount, for the family living is rarely considered in farming calculations. It is a significant fact that almost everybody but the farmer has a realizing sense of the cost of food, fuel, rent and repairs, and gives these things proper credit in business. The real income from a good farm is rarely known, and it may be laid down as a general principle for the benefit of young men that after meeting expenses incident to city life few salaries afford more than a comfortable living, and that people drawing what seems like princely pay practice economy in ways never dreamed of by the farmer. Half our population live upon land as against the other half that engage in business or serve for pay, and every well informed man knows that it is the landed half that is the best fed, the best clothed, and the best housed. While ability of a high order will always be in demand out in the larger affairs of the world, the land repays faithful attention better than does any other interest that employs any appreciable number of people. It is the only one that can or does support mediocrity in comfort or sustain the feeble or incompetent above the plane of destitution.

Our country has been for more than a generation phenomenally prosperous. The vast increase in material wealth has given rise to extensive business in manufacture, commerce and in transportation. Further this has been the period and to some extent this the occasion for the greatest development along mechanical lines, and the call has been persistent and the recompense liberal for men of

business energy and of technical skill. Inventive genius has been well repaid and so diversified have been the interests and so great the demand upon our meagre population that fair ability has been even extravagantly paid. Schools have been founded and courses established for technical training to fit young men for these new demands. First the business or commercial colleges, then manual training schools and the engineering colleges came into existence, and the graduates have been employed at generous salaries. But it must not be forgotten that what is a generous salary for an unmarried man is but a meagre one when he shall have a family. Nor must it be forgotten that these salaries are rapidly decreasing and that a graduate of a four years' engineering course starts today at about the same figure as did a graduate of a commercial college with six months' preparation, less than twenty years ago, and whose wages have correspondingly dropped. Again it must be remembered that all these people are being crowded hard from behind by successive crops of graduates fresh from the schools with up-to-date information. Whereas a few years ago these students were eagerly engaged before graduation, they now seek employment, and carry into the business world an equipment and an energy against which they of a few years' standing find it difficult to compete, and against which a rise in salary is well nigh impossible to secure.

Again new inventions are destroying the occupation of many a skilled operative and rendering his costly and hitherto valuable training worthless, while the man himself is left in the prime of life, but too old to learn a new occupation of an equally high degree of excellence, as witness the army of wood engravers whose occupation has withered before the process of photo-engraving.

If this is not enough to convince the young land owner that the palmy days of the salaried employe are waning let him know that an age limit is being set and that a man over thirty-five will find it difficult, if not impossible, to secure a position as locomotive engineer on a first-class railroad, and that one of our great western roads has set its age limit for firemen at twenty-six.

The experience of the world in all countries has been that as a country grows older, its population more dense and better educated, its business established upon settled and conservative lines and controlled by a large capital working on a narrow margin,—as all this comes about salaries grow smaller rather than larger. Whereas a premium was once paid upon superior fitness and extra faithfulness, now nothing less will satisfy, and withal the recompense is

less. This applies to all salaried positions, save a few of the highest in church and state.

This is not pleasant truth to write, because thousands of our best young men must engage in this sort of competition. The best of them will succeed, but many of them with good ability and after faithful service will find themselves at or after middle age like the wood engravers of the present, without an occupation, or, because of competition from the younger and better equipped of the next generation, obliged to take cheap service. This is written only that it may deter some who have possession of land from surrendering the natural advantage and entailing upon their descendants perpetual service. To a family owning land all things are possible, but if once surrendered it cannot, except with great difficulty, be recovered.

The owner of land possesses decided advantage if he will avail himself of it. While he may never amass great wealth, he will be assured of the comforts of life for himself and family. He will never be thrown out of employment and will enjoy the privilege of self-directed energy. He will be no man's employe. His profession will not disappear from the earth by the efforts of inventive genius. He will have leisure in which to live the fullest mental and intellectual life of which he and his family are capable. He will have ideal conditions for rearing a family, and, what is of much consequence, he will establish a business while the man on salary does not, and his land will labor for him under his direction long after his failing strength would make him useless as an employe. While he retains land he is a capitalist in a small but comfortable way, and if successful will become a gentleman of leisure.

He may cultivate much as he will whatever faculties nature has given him. He may represent his people in state and nation. No avenue of public service or of honor will be closed against him. The man upon land is the only independent citizen, for a good landed property is able to establish the family that occupies it among the people.

YOUNG EGYPT'S SONG TO THE NORTH.

BY JAMES NEWTON MATTHEWS.

Come down, come down to the orchard lands
That lie to the south,—come down and see
The beautiful Egypt whose lifted hands
Shall hold the fruit of the years to be;
Come down to the fields where the apples shine
Like clustered stars, and the heart grows light
Quaffing the odorous winds like wine,
In the drowsy hush of the autumn night.

O who would live in the corn-lands cold
Of the treeless North, when a soil like this
Is coining its heart into globes of gold,
And holding them up for the sun to kiss;—
Or who would live in the barren East,
Or who to the deserts West would go,
When Nature is spreading the richest feast,
Here, that her beautiful hands can show?

We blush no more at northern scorn,
But fair in your face we can snap our thumbs
And over against your boasted corn
Can pile our peaches, and pears and plums:
Go build if you will your palace of maize
High in the light of the cold north sun,
But think of the pyramids we shall raise
Of golden apples, piled one by one.

What is a king on a crumbling throne,
With a painted queen, and a pedigree,
When matched with the man who dreams alone
On the emerald plush, 'neath his apple tree?
The Lord He loveth all men, and so
Would lead their feet into ways divine,
But he counteth him best who toils below
In the peaceful shade of the Noble Vine.

Then come to the South where the vineyards are
And the prodigal bloom of the orchard burns
Against the blue, like a rising star,
Wherever the raptured vision turns;
Come down where the younger Egypt stands,
Like a princess under her apple tree,
Holding aloft in her plenished hands
The gift of the centuries yet to be.

FRUIT FOR THE FARMERS.

BY T. E. GOODRICH, PRESIDENT OF THE ILLINOIS STATE HORTICULTURAL SOCIETY.

I have visited nearly every portion of Illinois, have met her farmers on public conveyances, at institutes, on their farms and in their homes. I have met them under all circumstances of farm life and am always surprised at the lack of fruit. Their tables are painfully barren of this great necessity. No other class of our citizens consumes so little fruit as they, and a large proportion of what they do consume is bought, not grown.

Why this is so is a mystery yet unsolved. With the land, the teams and the tools; with the intelligence to plant and care for, they too frequently buy or go without. A few have all they can consume and a surplus for less fortunate friends and neighbors, a few have a partial supply, but the majority have a very scant allowance, or none at all.

Many a doctor or merchant, on a town lot, working during his leisure moments and chiefly for the love of it, produces a greater supply of luscious, health-giving fruit than scores of farmers on their broad acres, and the enthusiasm they show is refreshing to see. Why, I have seen ministers bring specimens of fruit to fairs and fruit growers' meetings that would be a credit to any fruit exhibit, and they discuss it and their mode of growing with equally as much eloquence as when discoursing on other themes in their own pulpits. Whatever their efforts may have been in changing the natural man to a more fruitful condition of good work and the cardinal virtues, their efforts as fruit growers were certainly a noble example and a beautiful object lesson to all fortunate enough to see and hear. I have in mind professors and physicians in the several educational and charitable institutions of Illinois, who, more from love of horticulture than from necessity, grow a surprising amount of fruit from a very limited area. These are men whose knowledge and opinion are eagerly sought for by the various societies of the land, showing

conclusively that the knowledge and skill acquired by them is within the reach of all.

For some unexplainable reason farmers seem reluctant to experiment for themselves, and not infrequently are reluctant to accept the results of the experiments of others. With abundant and reliable nurseries at hand and with express companies ready to lay down trees and shrubs at their doors, too frequeutly the farmer's table is without fruit and his dooryard without ornamentation. Is it any wonder that the boys leave the farm? The wonder is that they do not all go.

Let the farmers begin planting fruit and work up to a home supply. A few bushels of wheat or corn, even at present prices, will buy trees and plants enough for a beginning. If possible ascertain what varieties thrive best in one's own locality and plant them. If that is impracticable then take the following varieties as a suggestion:

Strawberries: (for early) Crystal City or Michels; (for medium) Warfield, fertilized with Sucker State; (for late) Gandy. Set 500 plants each.

Raspberries: Gregg or Kansas for black, and Cuthbert and Hansell for red. Set 100 plants each.

Blackberries: Early Harvest and Ancient Briton. If for a cold climate, substitute Snyder.

If but one kind of tree fruit can be planted let it be apples and three of each variety—Early Harvest, Duchess, Connell's Fancy, Jeffries, Ben Davies, Jonathan, Grime's Golden, and Minkler.

If cherries are to be planted set three trees each of Dye House and Early Richmond.

Of plums set Wild Goose and Burbank.

Of pears set Duchess (dwarf), Seckel, Lincoln and Kieffer. This pear list can be extended if these survive the blight.

THE AGRICULTURAL CLUB.

ALVIN C. BEAL, '97.

The Agricultural Club of the University of Illinois was organized in May, 1888. Among the names of the charter members appear those of Hunt, Grindley, D. H. Chester, C. A. Shamel, Gardener and Bopes. These men are now among the most honored alumni of the University. The first officers were: President, C. A. Bopes; vice president, C. A. Shamel; secretary, D. H. Chester. Notwithstanding the disadvantages under which the organization labored the aggressive young men made its meetings interesting and instructive. A feature of the early meetings of the society was the selection of a general subject, and then the assignment of particular parts to different members. For example, one meeting was devoted to agricultural papers and writers. The papers given were: "The Province of an Agricultural Paper," "General Agricultural Papers of the United States," "Live Stock Papers," Prominent Writers," "British Periodicals" and "Qualifications of an Agricultural Writer." During 1889-90 joint meetings were sometimes held with the Chemical Club.

The club led a prosperous existence until 1894-95 when, from the falling off in the number of agricultural students, and from the fact that the active men who had organized the club had graduated, successful meetings could no longer be held. One or two meetings were held during the winter term when the short course students helped make the program interesting.

With the opening of the fall term of 1895 came the largest freshman class in agriculture that had entered the college for years. A few enthusiastic members of this class believed that a greater interest in agricultural work could be stimulated by an organization in which the members of all classes could meet and discuss topics of interest to the agriculturalist. They decided to reorganize the club. For this purpose a meeting was called November 9, 1895. The following officers were elected: George E. Lake, president; A. D.

Shamel, vice president, and E. W. Mitchell, secretary. Mr. A. D. Shamel was elected to represent the club at the State Farmers' Institute at Springfield in January, 1896. Mr. Shamel read a paper on "The Farmer's Boy," which was greatly appreciated by the audience. On February 8, 1896, a large audience was present to hear Mrs. H. M. Dunlap speak on the "Preparation of Food." Miller Purvis of Chicago, Professor Davenport and Senator Dunlap also spoke at this meeting. During the year Professor and Mrs. Davenport gave some very interesting talks on the "Manner, Customs and Life of Brazil."

When the fall term of the present year opened the work was again taken up and the meetings have been held regularly. On February 28th the club held one of its largest meetings. Domestic science and the need of such a department in the University was the subject for discussion. The following addressed the meeting: Mrs. Dunlap, Mrs. J. C. Carter, Professor Parr, Miller Purvis and Miss Morrison.

The officers are: President, F. D. Linn; vice president, J. A. Latzer; secretary, E. T. Robbins.

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PICTURES OF FARM LIFE.

BY MRS. L. G. CHAPMAN, FREEDOM, ILL.

It is universally conceeded that no industry in this country compares in value and importance with the industry of agriculture. There is no calling more elevating to the mind or healthful to the body than tilling the soil. God in the beginning set his seal upon it and made it honorable, and it is the duty of those to whom this great heritage is transmitted, from generation to generation, to keep it on a high plane.

It is true that we are not altogether the arbiters of our own fate and yet life in a great measure is just what we make it. The mistaken idea that prevailed in the past history of the country, that the man who was fitted for no particular vocation should be a farmer, has been detrimental to the advancement of agriculture. A successful painter was once asked with what he mixed his colors. His answer was "brains." The farmer who mixes brains with his work and lives up to his privileges, elevates his calling and helps to place agriculture on a higher and broader plane. Farmers, by the nature of their calling and their environments, differ somewhat from other classes and are calculated to live more nearly within themselves. As they feed and clothe the world they know that there is always a cash demand for their products, and although seldom becoming wealthy they are assured a comfortable living and cannot be starved into submission by any combinations that may array themselves in opposition to their interests. Hence their independence.

There are many phases of farm life and various ways of looking at them. As one star differs from another star in brightness, so does one farmer's life differ from another's in environments, opportunities and accomplishments. Only those who are practically familiar with actual farm life can picture its lights and shades, paint its sunshine and shadows or read its poetry and prose. In the portrayal of the changing scenes of farm life one must begin

with the lowest stratum of shadows and ignorance and work up to sunshine and knowledge.

First, there is the plodding farmer with his monotonous round of drudgery who has no ambition to rise above the level at which he started. He cares for nothing higher than the every day routine of seed time and harvest. He plants his crops "in the moon" and harvests them in some "sign of the zodiac" because his father and grandfather did the same. His farm animals are poorly bred and he does not often seek to improve them. His poultry, a mixed variety, roost in the apple trees and hatch their broods in nests stolen in the weeds. He trades his butter and eggs at the corner grocery for groceries and tobacco, sits on a dry goods box for hours whittling a stick, talking politics and complaining that farming does not pay. He poohs at the idea that anyone can learn farming from books and would not read an agricultural journal if his neighbor paid his subscription. This is the shady side of farm life, the page of prose that is not threaded with a line or two of poetry to lighten it up as a glint of sunshine brightens a cloudy day. Happily this phase of farm life is becoming rarer every year among agricultural people. Farm life is not all sunshine, neither is it all shadows. However, shadows tend to make sunshine seem the brighter by comparison.

Next, we find the man who rotates his crops occasionally and diversifies his farming but does not recognize scientific principles because he has not studied the science of agriculture. His stock are well bred but not registered. His poultry good all-purpose fowls, are housed and fed, but are not fancy breeds with perfect markings. Agricultural journals and a city daily are on his table. A good library, music and other evidences of culture are in his home. He does not complain that farming does not pay. When agricultural depressions occur he looks forward to a failure of crops, a foreign war, or a change in the administration to regulate prices. He is fairly optimistic in his views of life and upon the whole is contented and satisfied with his lot. He prides himself upon being a level-headed, conservative citizen upon whose shoulders rests the welfare of the republic.

No man who is perfectly satisfied with his condition in life ever rises to a very high position, or is to any great extent a benefactor to the world. It is the uneasy, restless spirits, the "cranks" and "calamity howlers" that bring about reformations. The man with a desire to rise and reach out is the one who elevates his calling by

studying the philosophy of his business and making scientific investigations which advance the interests of his class. This man we do not find in the middle stratum just pictured, but in the very highest, above and beyond the thickly settled plane where dwells the average Illinois farmer.

He is the live up-to-date, progressive farmer who has chosen farming as his life work because he loves nature, and delights in its ever varying panorama which is presented most beautifully in the broad fields of the country. Having chosen his vocation, he makes the same preparation for it that he would had he chosen a profession. He takes a course in an Agricultural college and earnestly devotes his time to the study of agriculture. When he returns to the farm, nature is an open book from which he can read without an interpreter. He understands the composition of the soil, knows what elements are taken by growing different crops and how to best maintain fertility. There is no guesswork or haphazard methods used. He calculates the cost of everything, and knows when crops are grown at a loss, and by reading the papers keeps informed regarding the markets. Through his scientific knowledge he can prepare a food ration that will keep his stock cheaper and in better condition than they can be kept under the system of unscientific feeding. His neighbors may call him a book farmer, but they will be watchful of his career, and, noting his success, unconsciously learn to adopt his methods. His home is a model of neatness and comfort. His barns are built for convenience and by systematic management less help is required to perform the labor. His education does not cease with his college days, but through books and periodicals he keeps in touch with the world, and being broad minded is willing to disseminate his knowledge for the betterment of agriculturists. Through the agricultural press the public receive the benefit of his education and experience. His knowledge of the world has taught him that all classes, from the railroad magnate to the bootblack, organize for their mutual protection and the advancement of their business interests, and he is farseeing enough to know that the farmer cannot meet organization successfully when he is in an unorganized condition. He therefore organizes his fellow farmers into a Grange, that great educator of the farmers and their families, and through the medium of this social, literary and business organization, his light shines for the benefit of those who have not had his opportunities or were not progressive enough to grasp them.

There are three distinct phases of farm life—the lower, the

middle and the highest. Each has its influence, for there is no life so dull and colorless that it does not reflect some shade across the pathway of those with whom it comes in contact. Longfellow told what every one who has given the subject a thought knows to be true, when he wrote these lines in The Psalm of Life:

"Lives of great men all remind us
We can make our lives sublime,
And departing leave behind us
Footprints on the sands of time."

But it is not only the lives of the great men of the world that cast an influence over the lives of others. If this were really true, the world would be better than it is, but no one is born with natural abilities, and grows to man's estate that does not wield an influence for good or bad. He cannot journey through the world without leaving foot prints and it is our privilege, as well as our plain duty to ourselves and to those who come after us, to make our footprints straight and regular, perfect in form, methodical and systematic as those described in the third picture.

This is the ideal phase of life in the country. It is not attainable in the highest degree by all, but can be approximately reached by those who live up to the best there is in them. It is true that but few can occupy the front seats in life, but it is an inspiration to know that these seats are not reserved for a favored class, but open alike to the farm boy and the scion of aristocracy.

There is no royal road to success, no golden ladder to the hill of knowledge. All depends upon ourselves, our individual efforts and steady application to business.

"In the world's broad field of battle,
In the bivouac of life,
Be not like dumb driven cattle:
Be a hero in the strife."

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THE DAUGHTER OF THE FARM

And the College of Agriculture.

BY MRS. VIRGINIA C. MEREDITH, CAMBRIDGE CITY, INDIANA.

Like the good mother Eve her daughters through all the ages have had to make their own struggle for knowledge. While it is true that Universities have been endowed and young men fairly pushed into them it is also true on the other hand that young women have had to beg admittance and often been met with denial. Following the admission of women, however, we find the college curriculum taking on a new character, one in some harmony with life as we live it. Even during the last year we have had the spectacle of learned presidents and professors arraigning the University education because it does not enable a young man to speak his native tongue with ease, because it does not help him to choose a wife with prudence nor teach him how to take care of his body intelligently. One might well think that a scheme of education which has not a place for these prime factors in life "needs grievously to be fixed."

MRS. MEREDITH.

It is refreshing and encouraging to know that in the Colleges of Agriculture established under the Morrill bill we have in some of the middle and western states a good beginning for the adequate education of young women. The germ, at least, of an education that fits one for her environment, in fact the real application of the

principle enunciated by Comenius three hundred years ago—that the teaching of words and things must go hand in hand.

Men have devoted great brain to little businesses until these have become so thoroughly systematized that elements of profits and loss are so nicely classified and so accurately estimated that it pays to offer prizes to the engineer who will use the least "waste" in oiling his engine! Indeed the waste of slaughtered animals is managed so that it becomes a princely profit! In the meanwhile women have been carrying on the business of housekeeping with an equipment in the way of knowledge and preparation so meager as to awaken wonder when viewed in its true proportions; and yet housekeeping (and under that term we usually include homekeeping) is not only the most important and the most difficult, but also the most expensive *business* known to modern times.

Fortunately with the closing century comes a kindly light. Even a Cabinet officer, in his annual report to the President of the United States, mentioned the farm home and the need there is that women should receive "some systematic teaching of the arts which are practiced in the home," and he also recognized "that much remains to be done before the teaching of domestic science can assume its most effective form."

That Schools and Colleges of Agriculture are establishing a Department of Household Economics is a precious harbinger of good. These schools are opening to the alert daughters of the farm a new world of interest; her horizon is broadening and she may grasp the colossal fact that the home life is the excuse, the sole justification of all knowledge, of all investigation in science, all labor in art.

Household art is now being taught from the standpoint of the suitable, and that principle, which has heretofore eluded definition, but which we have recognized in the really attractive kitchen and missed in its neighbor, the horrid parlor, is being formulated so that harmony of color and form and use may be within the possibilities. Housekeeping and home-making are in process of being diagramed so that the elemental essentials may be recognized and practiced. Home economy may be separated into its factors and classified with as much precision as lines and angles in geometry, and surely no one will object to the propriety of teaching women the just relation between expenditure and income as well as the just proportion of expenditure for existence, comfort, culture

and philanthropy with due regard to saving and sources of income. Men earn money and women spend it; serious reflection will soon discover that the spending ought to be the finer problem. When we shall have so educated the taste and enlightened the understanding that only beautiful and useful things are bought and brought into the home we shall have wrought a great service for the farm home and the farm family.

Cooking, sewing and laundering are so directly connected with comfortable living that there is not room for two opinions in regard to the desirability of having each practiced in the best way. How can they be correctly practiced unless they are correctly taught?

The unthinking may say these things are not worth teaching—possibly may declare they cannot be taught. But do we not find that we have to be taught everything from walking to thinking? And, strange as it may seem, some things are taught better away from the home than in it. Nothing in cooking, sewing, laundering, home management, spending and saving differs radically from the alphabet and the multiplication table in the quality of adaptability for being taught in an orderly way by a trained teacher. The mother may in fact know her multiplication table better than she knows her cooking, yet she would not presume to teach her son his arithmetic at home—should she teach her daughter cooking at home? But the alert daughter of the farm will find in the School of Agriculture fascinating interests outside of Household Economics, the regular course ought to appeal to her taste and to her intelligence.

One who will investigate the census reports will find a very considerable number of women classified as farmers and indeed it is one of the oldest forms of business prosecuted by women. One needs only to look about in any community to find aged women who, becoming widows early in life, have continued to live on their farms, managing them so successfully as to have been able not only to keep the farms and make a living from them, but able also to give to their children the best education in Academy and University. Many widows have failed in such endeavors; likewise many men have failed of success in farming. When one has a true conception of what farming is one can readily understand why it is a suitable business for women and also why women are essentially suited to become farmers. Real farming consists, first, in knowing the relation of certain scientific principles to soil fertility, to plant and animal growth; second, knowing how to apply this knowledge, that

is, how to cultivate the soil and to feed animals. This includes, naturally, the management of farm labor and also a study of the trend of markets in order to keep the energies of the farm in line with profit. Possibly the most significant element in successful farming is a proper understanding of one's own aptitude. Fortunately the room for choice is so ample that in farming one may choose the painstaking work of the horticulturist where concentration of labor and knowledge accomplish so much—or one can take the larger and less complicated form, grain growing. But with her aptitude for care taking, added to the peculiar fascination found in the responsive quality of all animal life, the woman farmer will probably choose and succeed best in live stock farming. The pure breeds of cattle, sheep and horses are a perpetual delight; the literature belonging to their history is an unfading source of pleasure and the associations they make with the most advanced farmers will add perceptibly to the pleasures of life.

Naturally the first comment upon the subject of women becoming farmers is the query—how can she get a farm? The answer is obvious—the inheritance laws of this country give lands to the daughter just as to the son. I happen to know one particular community in which all the land on one side of the road for six miles belongs to women. What an opportunity for the women who own those farms to make an ideal farm community! But alas, not one is farming her own land—all renting—the farms growing less productive each year, fences down, barn doors hanging by one hinge, dirty dooryards and all the usual marks of neglect. Within driving distance of these farms, however, we will find other farms managed by women and with fields clean and well tilled, stock thrifty and sleek, clean barnyards and neat premises. Farming is managing and there is a good moral in the old story of the farmer who never had such a prosperous year as that in which he broke his leg and could not plow. We are not paid for perspiring, and who has not seen the one who drives about in a buggy over the hay field earn more than any man who handles the fork? There is nothing in the practice of farming beyond the capacity of a well educated young woman, while there is much which is beyond the man who brings only his muscle to the business. One who is at all wide awake readily sees the application of the principles in physics learned at school. To illustrate: A woman was putting down a carpet in the kitchen where sat a large cooking stove; after spreading the carpet

and tacking it on the farther side she found herself at a standstill and sought the mistress to ask that men from the barn be called to lift the stove. "Oh no," replied the mistress, "just bring a 2x4 stringer and a block from the wood house, then I will show you how to lift it alone." And of course the stove was balanced and raised an inch without the expenditure of as much energy as is required to lift a pail of water from the floor onto the table. The same kind of knowledge is applied in adjusting trace chains, the

Minnesota's Building Where Domestic Economy is Taught.

plow point and innumerable things that unite to make up the sum of farm practice.

In the matter of hired men it will often be noticed that the best man in the neighborhood is working for a woman. He likes to be thought of as having a certain independence which all his friends believe belongs to "working for a woman," he likes the attitude of consultation which the mistress is likely tactfully to assume, he finds often shorter hours though rarely less work, he finds

a woman's dollar quite as current as a man's dollar, he finds, too, a certain consideration for the welfare of his family quite agreeable. So on the whole the best hired men will take a situation and follow instructions as cheerfully with a woman farmer as a man farmer.

When the market is considered, farming has a very definite advantage over any other business in which a woman can engage. In the government employ, in teaching, in clerking, in factories, indeed wherever they sell their ability to do something, the price obtained by women is uniformly less than men command, the mere matter of sex being the reason for the discount. But when a bushel of wheat, a fat steer, a fleece, a cord of wood goes on the market no buyer asks or cares whether the farm from which it came is managed by a man or woman. Moreover, farmers as a class have the largest sympathy and tolerance for women. They not only have no antagonism, but are helpful toward any woman who wishes to farm, an attitude in pleasing contrast to that of doctors, lawyers and preachers.

We live in an earnest age when to sit idly down with folded hands is thought unworthy. The spur of necessity is not the noblest incentive—one who worthily does that which lies nearest her may become a tower of strength to many weaker ones. Let the alert daughter of the farm seize with energy the opportunities to acquire the high education suited to her environment now offered by the College of Agriculture. It will help and not hinder her afterward though she become the Governor's wife; it will help and not hinder though she make the struggle of life alone.

SMUT ENEMIES OF THE ILLINOIS FARMERS.

BY G. P. CLINTON, ASSISTANT BOTANIST.

What Are Smuts?

The writer has no doubt but that all of the readers of this article have seen some of the smuts that appear on various plants, such as oats for instance, and possibly may know in a general way the nature of these dusty outbreaks. To make the knowledge certain, however, let me state that such sooty outgrowths are part of a plant which is just as truly a plant as the forms upon which it occurs. Of course, the smut plants are very low in the scale of vegetable life, belonging to what is known as fungi. All the smuts, moreover, are parasites; that is, they cannot obtain their food from the ground or from decaying matter but must grow on living plants and from them extract their nourishment. This being the case we call them parasitic fungi and the plants upon which they grow, their hosts.

Perhaps we may obtain a clearer idea of them as plants if we inquire into their life history. If we should take some of the dust from one of the smut balls that occur, for instance, on the corn plant, and examine this under the microscope, we would find that we had there millions of very minute spherical bodies. These we call the spores and they make up all the fungus that is visible to the naked eye. The spores are similar in function to seeds in that they are the means by which the smut plant reproduces itself. They germinate when placed in water by sending out a slender tube which has the power of penetrating into the tissues of its host or which forms other smaller spore bodies that have this power. (*See Figs.* 2 *and* 3.) However, these germinating threads do not have the ability of so penetrating except when the parts are very young and tender, and in many cases only into the very young tissues of the germinating seed.

The germ threads of the spores once having gained entrance into the plant, through the germinating seed for example, multiply, by the use of the food found there, into a network of threads that, pushing their way between and into the cells of the host, follow its upward growth. All this time there are very little or no external signs that the infected plant is different from one that is not. If, however, we should cut out thin sections of the stem, especially at the joints, we would find such growing threads of the fungus as are shown in Figure 1 (pith cells of broom-corn infested with broom-corn smut.) Now when the plant begins to form its seed, the fungus is also getting ready to form its spores at the same place. The result is that the fungus usually succeeds in transforming into a sooty mass of spores the parts that would normally have developed into the flowers or the seeds.

To illustrate the foregoing development let me give the following experiment: I took some broom-corn seed and mixed with it an abundance of spores that had been obtained from smutty broom-corn, and then I planted the seed. This germinated normally and developed during the season into plants ten or twelve feet in length, but I saw no signs that they were infested by the fungus until their panicles appeared over two months after the seed was placed in the ground. It was then found that these panicles had their seeds all smutted. (Other plants that had no spores on their seeds when planted were free from smut.) Now I know for certain from other experiments that the smut spores infected the germinating seeds and that their vegetable threads followed the upward growth of the plants through the twelve feet of stalks that were formed, even though the fungus only became visible to the naked eye by its spore production in the smutted flowers.

While it may not be an universal law with these fungi, yet evidence seems to indicate it at least as the common law that where smut breaks out only in the flowering parts successful infection takes place as the normal thing only through the germinating seeds. In some plants, however, the infection of the smut is wide-spread; that is, can take place anywhere, apparently, through very young tissues, and in these cases the smut does not usually spread far from the place at which it gains entrance (unless it be in the seedling) and appears in its spore-producing stage soon after gaining entrance. This is the case with corn smut, where we find the smut balls appearing on any part of the plant above ground, and,

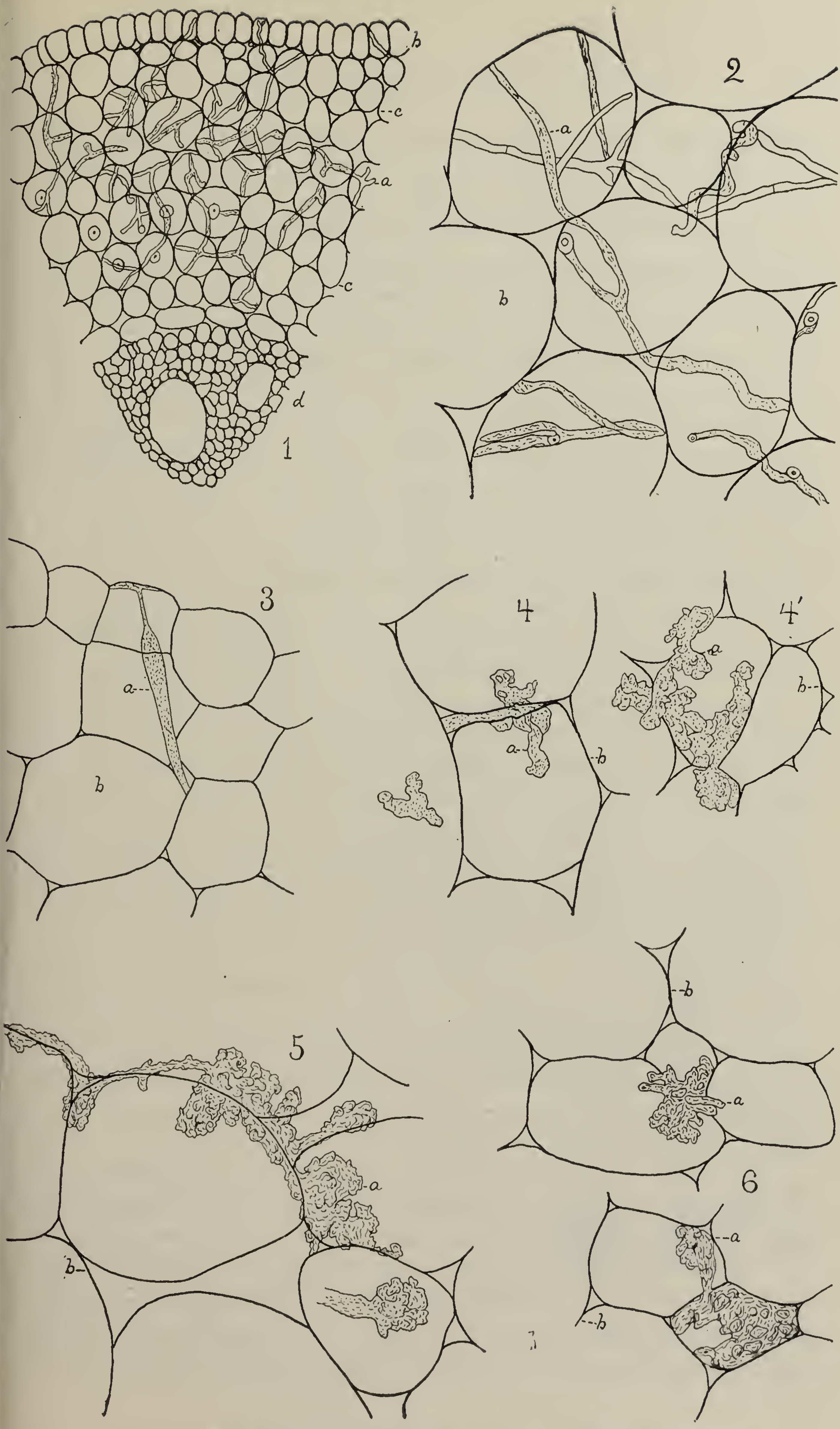


Fig. 2. Pith cells of broom corn showing fungus threads.

sometimes at least, maturing their spores within a month after the infection of the host.

DAMAGE CAUSED BY SMUTS.

From what has been given it can readily be seen that the smut fungus develops at the expense of its host. Now, when this is an economic plant, any injury to it means a corresponding loss to the grower. Because of their commonness and because of the violence of their attack, the smuts are among the most injurious of the fungus foes of our agricultural plants. The injury to the host occurs in two ways: first, by loss of food, thus weakening it; and second, by destruction of certain of its parts. When the seeds are thus destroyed, as in certain of our cereals, this injury becomes quite a serious matter, and the loss of the grower is easy of computation. Thus a farmer can get a fair idea of the damage done to his oats crop by going over the field and determining the per cent. of smutted panicles. This, however, does not give the exact loss as the smut often infects and weakens a plant without succeeding in smutting its grain. Estimates made in this way on the per cent. of visible smut in the fields of a number of our states have shown losses of millions of dollars due to this single species. It is not my purpose to give figures to show the losses caused by smuts in this state. In fact all such figures are merely estimates or guess work, because in no case has an accurate survey of most of the fields been made. There can be no doubt, however, that we suffer large losses from the depredations of these fungus foes, and in the light of present investigations these are largely needless losses.

KINDS OF SMUTS.

There are different kinds or species of smuts, just as there are different species of oak trees or golden-rods, and these different species have each their special host or hosts that they inhabit. In Illinois there are at least fifty species occurring on over sixty host plants, and of these species about a dozen occur on our cultivated plants. Let us briefly consider these economic forms.

Oat Smut. This is undoubtedly one of the most injurious of our fungus foes. It confines its spore production to the flowers of the panicle, turning these into a dusty mass in which usually is left very little of their parts, as with other grain smuts when a panicle is infected all of its grain is commonly destroyed and usually most of the culms from that stool will be found to be smutted. This smut, while common all over the state, is most injurious at present in

the hard pan district of southern central Illinois. Last year the writer made a trip across country from Champaign to Neoga, Effingham, Vandalia and Decatur. Over one hundred fields were examined and the per cent. of smut determined by counting several thousand panicles in different places in each field. In the region south of a line from Neoga to Pana nearly every field visited showed from ten to thirty-five per cent. of the oats smutted. Information by letter and otherwise also indicated that the region south of that visited was as badly infected. Some of the farmers also claimed that the loss was not so great as it had been the preceding season. As experiments at our agricultural experiment station and elsewhere show that oat smut can be prevented, this loss seems to be an unnecessary one. Figure 2 shows the germinating spores of oat smut.

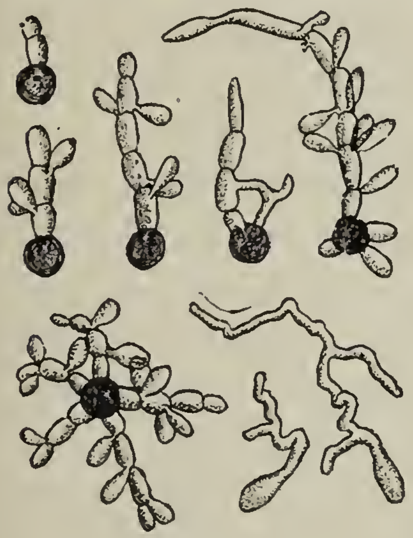


Fig. 2.

Loose Smut of Wheat. This is similar to oat smut and in fact until recently was even considered by botanists to be the same. It usually more completely destroys the infected flowers, leaving only the naked spike at the end of the season. It is not generally so abundant as the oat smut and is not now so important to us because of the decline of wheat growing in the state. It is, however, a form that in wheat districts causes considerable damage. Unlike oat smut it is not so easily prevented, and the treatment necessary to its prevention seems to be such as is somewhat injurious to the seed.

Stinking Smut of Wheat. There are two species of smuts of this character which very likely occur on wheat in this state, though the writer has found but one of them. The first part of their name is quite descriptive, especially, it is said, when very smutty grain is thrashed. These smuts are not so easily detected in the field because the spores, instead of destroying all of the flowering parts, are formed only inside of the grain, giving it a shape and size somewhat like a sound seed and leaving glans wrapped around it in a normal condition.

Fig. 3.

If such wheat is made into flour it is difficult to keep out the smutted grains and so the flour is of an inferior grade. Stinking smut unfortunately has occasionally been reported as quite injurious in the wheat raising districts of the state, but, fortunately, it is one of the forms that can be controlled by proper treatment. Figure 3 shows the germinating spores of one of these stinking smuts.

Corn Smut. This is one of the best known and most widely distributed of smuts. The loss it causes, however, is quite variable. In this state its injury seems to be not so much due to a direct loss from smutted ears as perhaps to the indirect effect on such plants in producing fewer and smaller ears. It is hard, however, to obtain a correct idea of the damage done except by a careful study of the total yield of corn from the free and the infected stalks of a field. As has been stated this smut is different from the preceding in that the outbreaks occur on any part of the plant, and that infection is not limited to the seed. Of the many experiments tried by the writer to prevent this smut all have failed. Another host upon which it occurs in this state is teosinte, a tropical plant related to corn and is occasionally grown here.

Fig 4.

Grain Smut of Sorghum and Broom-Corn. Illinois possesses one of the largest broom-corn districts in the world ; she also raises in various parts of the state considerable sorghum. The grain smut of these plants, as its name indicates, forms it spores in the seeds, these being transformed something after the manner of the kernels of the stinking smut of wheat. The losses caused by this smut are the destruction of the seed, which often is one of the sources of profit, and in broom-corn the production of inferior "brush," and in sorghum a

possible loss in the amount of molasses that can be made from the infected cane. While this smut is usually not very bad, still the writer has seen large fields of either lost where over twenty per cent. of the canes were infested. Figure 4 shows several of the infested flowers of broom-corn.

Head Smut of Sorghum. Unlike the grain smut of the same host this smut transforms the whole panicle into a very conspicuous smutty mass. Comparatively little is known about the life history of this species and so nothing definite can be stated as to its prevention. It was reported last season for the first time in this state, although it may have occurred here for some time.

Grass Smut. Upon timothy, red top and blue grass there is occasionally found a smut that shows it presence by slender dusty outbreaks on the leaves. This is not a very conspicuous form and is perhaps most injurious to timothy, as once appearing in a field it is apt to be found as long as the grass is kept there. Its life history has not yet been carefully studied, and it is hardly important enough to demand preventive measures.

The above include the most prominent and common of the smuts* of our cultivated plants. The damage they do in various parts of the world have caused investigations to be carried on looking to the prevention or limiting of their injury. Let us spend a short time in considering this subject of

PREVENTION OF SMUTS.

As was stated in our discussion of the life history of these fungi it is now known that most of the preceding forms gain entrance into their host through the germinating seed. Methods looking to the prevention of the smuts then, must be directed to keeping the seedling away from the smut germs until they are old enough to escape infection. Usually after such plants have appeared above ground any danger in this direction is past. Before this time, however, there are two ways that the host may become infected; namely, by spores in the ground in the immediate vicinity of the germinating seed or by spores which have adhered to the seed itself. Experience has shown that as a whole there is very little danger from the first of these ways, perhaps because spores never become abundant enough on the ground. Preventive measures, therefore, have been almost entirely directed toward seed treatment or selection.

*Barley and tall meadow oat grass have each been found infected with a smut, but not very often or abundantly.

Smut produced in abundance in the fields is very apt to have numerous spores become attached to the healthy seed. It is to kill these spores, without injury to the seed, and so prevent infection that seed treatment is undertaken. The methods of selection and treatment employed have been along the following lines:

Selection of Seed. From the preceding discussion it will be evident to any person that one of the most efficient ways in keeping smut out of a field is to select seed from a crop that is entirely free from it. Very few fields, though, have no smut in them and the tendency, where the same smutty seed is used year after year, is for the percentage of smut to increase. The season, however, as well as the presence of spores, has something to do with the amount of smut that is developed.

One can depend, nevertheless, that if he selects seed from a very smutty crop he will have more smut in his field than if he had selected seed from a less smutty crop or nearly free crop. The farmer should watch his fields from year to year to see if they are becoming smuttier and to determine if the smut is abundant enough to cause serious loss. While with a field having only two or three per cent. destroyed it is hardly worth while to go to much trouble to prevent this loss, still, on the other hand, it may be worth the trouble, since a favorable season might develop a much larger loss from such seed.

Treatment With Chemicals. It has been a not uncommon custom for many years and in various countries where serious loss was caused by smuts, to treat the seed with certain chemical solutions as a preventive measure. One of the oldest and most beneficial treatments is the use of copper sulfate (blue vitriol) in water. In the last few years potassium sulfid, Ceres Pulver, corrosive sublimate and formaline have been recommended by various investigators as possessing decided merit. There are two ways by which this treatment may be given. First, by immersion of the seed in a solution of the chemical for a longer or shorter period of time, depending on the strength of the solution, or second, by sprinkling the solution of a given strength over the grain, thoroughly mixing the two during the sprinkling. On account of the ease with which it is accomplished and because of the larger amount of grain that can be treated in a short time, the latter method is the most practical one. It is, however, a method that with very smutty grain perhaps does not prove so effective as the former. The chief objections

to seed treatment with chemicals are the cost and the danger of injury to the seed, this latter being especially true with the copper sulfate treatment. These various chemicals are being tried at our agricultural experiment station to test their relative efficiency.

Hot Water Treatment. Experiments made in Europe, in many places in this country and also at our agricultural experiment station, show that dipping seed in water of certain temperature for a certain time will kill the attached smut spores and not injure the seed and give a crop practically free from smut. The following details for its use are given with the view of making the operation as simple as possible:

Have some means at the place of treatment for heating a quantity of water; a supply of cold water; a large barrel for holding the hot water in which the seed is to be treated; a reliable* thermometer for testing temperature of the water; a coarse gunny sack capable of holding a couple of bushels for holding the grain when dipped into the water; a clean barn floor or canvas in the sun for drying the seed.

Fill the barrel about three-fourths full of hot water, and regulate its temperature so that the thermometer reads 135° F. Now immerse in the water the sack containing a bushel or so of the seed to be treated. There should be plenty of room in the sack to allow free access of water, and it should be raised entirely out of the water several times at first to drain off the water so that the water in contact with the seed is not cooled below the bulk of the water. This process will lower the temperature of all of the water. If the temperature falls below 130° F. add boiling water (while the grain is lifted out) and stir until the thermometer records 130°-132° F. After the seed has been in the water 8 to 10 minutes take it out, dip in cold water to cool off the seed, drain off the water and immediately spread it out on a clean floor or canvas to dry, raking over once in a while to hasten the drying. Repeat the operation with another lot of seed until a sufficient quantity has been treated. If the grain is sown broadcast it can be planted without waiting to dry. If a drill is used care should be taken in setting it so that the usual amount of seed per acre is used, as the seeds are apt to be somewhat swollen and also may not feed so well as perfectly dry

*The ordinary cheap thermometer frequently varies five degrees at the higher readings and so are hardly to be trusted for the operation unless compared at their higher readings with a reliable thermometer.

seed. The seed may be treated at any time during the year, but should be thoroughly dried if not planted immediately.

The above operation is for the prevention of the loose smut of oats, the stinking smut of wheat, and broom-corn smut. Corn smut can not be prevented by seed treatment; neither has the hot water treatment been found successful for the loose smut of wheat or barley smut unless it is considerably modified from this operation. In case the broom-corn or wheat seed to be treated contains numerous smutted grains, it is best first to place the seed in cold water and after stirring it to skim off the floating smutted grains. Also in the case of broom-corn the temperature may be kept as high as 135° and the seed should be left in for 15 minutes, as this seed is not so easily injured by hot water. Mechanical devices for lifting grain in and out of the barrel (such as a lever on a cross-bar) use of steam from engine boiler, etc., are helps that can be provided to suit the conveniance of the operator. Two persons are needed where considerable seed is to be treated—one to regulate the supply and temperature of the water and the other to immerse the seed.

The chief objections to the hot water treatments are its cumbersomeness and the difficulty of drying the seed; both of these objections, however, are more or less true of all treatments. The writer believes that the most feasible method where a farmer raises his own seed is to treat a small amount and place this by itself at one end of the field (or better away from any similar crop) and then from the resulting crop select his seed for another season. Such a proceedure would necessitate the treatment of only a small amount of seed and perhaps not oftner than every third season or so, after the smut had once been reduced to a minimum. Broom-corn and sorghum, however, require such a small amount of seed per acre that all of the seed used could easily be treated.

VARIATION IN CORN.

BY A. D. SHAMEL, CLASS OF 1898.

Variation has always been a subject of close study among the breeders of live stock. It is by means of variation and judicious selection that we have brought our domestic animals up to the high state of perfection at which we now find them, and we find that it is among those breeds of stock which have the greatest capacity for variation that we have developed those strains or breeds that are the most valuable to man. Heretofore most of the study has been directed along animal lines, but we have now begun to question whether plants are not as susceptible to the influence of environment and careful crossing as are animals.

It was in the hope of throwing some light upon this question and to find out if possible whether these variations, if such variation could be produced, were transmissible and fixed by heredity, that a number of experiments were begun at our experiment station. Realizing that one of the most important plants in our agriculture, if not the most important, especially to the farmers of the Mississippi valley, was Indian corn, it was determined to use it in the experiments. The following discussion will deal with the results of these experiments in so far as they have brought out any facts bearing upon this question of variation. Of course it must be understood from the start that there were two factors involved in this experiment: first, the bringing about of variation, and second, the perpetuation of these variations by selection through heredity. We shall deal for the present mainly with the first factor, in view of the fact that a number of years will be required to determine definitely whether these variations can be fixed and become inherited from generation to generation. For the present then we can only argue from analogy in relation to this second factor, from experience with animals, and give such evidence as has been developed from

other plants than Indian corn, especially among florists' flowers, together with any facts which we have found out about Indian corn itself.

The first experiment with which we shall deal will be with the width of leaves. The experiment was begun in 1895, when seed was selected from those stalks having wide leaves, on the average $4\frac{1}{2}$-5 inches wide. In 1896 the stalks grown from this seed were found to bear leaves which by close observation could be seen to have gained slightly in width, although no actual measurements were taken. Seed was again selected from those stalks bearing leaves $4\frac{1}{2}$-5 inches broad, and this seed was planted the present year, 1897. Two plats were planted, and beside these plats, ordinary Burr's White was planted on which no selection had been made. It should be said that all the corn in these experiments was Burr's White. During the early part of the season a marked difference could be detected between the width of the leaves on the wide-leaved plats and the ordinary plats, even by the most casual observer. As the corn increased in size this difference became more and more marked. In a short examination in August it was found that many of the broad leaves were 5 inches wide, while some of the leaves were $5\frac{7}{8}$ inches wide, while most of the leaves measured were between 5 and $5\frac{1}{2}$ inches in width. On the ordinary corn the leaves were on the average from 3 to 4 inches in width. Not only was this true, but on the wide-leaved plats it was found that the mass of foliage upon the stalk was much greater than in the case of the ordinary corn. The stalks were heavier and had a stocky growth with large and well-developed brace roots, while the foliage began at the base of the stalks and the leaves were thickly set upon the stalk its entire length. At the end of the season after the growth was completed a measurement was made of the width of the leaves in both the experimental corn and the ordinary which grew alongside. The following is the average of 60 measurements:

Average width of leaves on broad-leaved plats—	*Average width of leaves on ordinary plats—*
$4\frac{2}{3}$ inches.	$3\frac{2}{3}$ inches.

This shows a gain on the average of one inch in two years' experimentation.

The yields from the plats were as follows:

	Broad-leaved plats.	*Ordinary.*
No. ears............	134	182
Weight of ears......	$104\frac{1}{4}$ lbs.	$98\frac{3}{4}$ lbs.
Missing hills........	4	5

It will be seen that although from some cause, probably an excess of seed in the case of the ordinary, the ordinary had by far the largest number of ears, the ears in the case of the wide leaves were so much better developed that they actually out-weighed the ears on the ordinary plats.

Another experiment was conducted along similar lines, but with a different object in view. In 1895 seed was selected from leaves 3 inches in width and in 1896 a slight difference could be detected between these narrow-leaved plats and the plats of ordinary corn. This year the difference was very noticeable. Not only had the leaves decreased in size and width, but the whole stalk was small and the color was not the usual dark green of healthy corn. Not only was this true, but the stalks bore only a a scant foliage and the height of the stalk itself was materially decreased. The following results are the average of 45 measurements taken at the end of the season after growth had ceased:

Average width of leaves on narrow leaved plats—	*Average width of leaves on ordinary-leaved plats—*
$8\frac{1}{6}$ inches.	$8\frac{3}{4}$ inches.

The decrease in width has amounted on the average to over one-half an inch, but the decrease in total amount of foliage was very great.

The yield upon these plats was as follows:

	Narrow-leaved plats.	*Ordinary.*
No. ears............	190	166
Weight of ears......	$102\frac{1}{2}$	$95\frac{1}{4}$
Missing hills........	000	6

Taking into consideration the number of ears, and the number

of missing hills, the yield upon the ordinary plat is greater than the yield on the narrow-leaved plats. It was also found that the ears on the narrow-leaved plat were decreasing in size and quality, not being filled out in most cases, and the grains were small and very irregular.

The next two experiments will be considered together under the same head. The first has to deal with the ears protruding from the husk, and the second, husks protruding over the ears. In the first case it was found that in the first plat (*a*) out of 79 ears in the plat, 36 of these ears protruded out of the husks in a prominent manner so that at least one inch of the corn was exposed. In the second plat (*b*) out of 65 ears, 24 of them protruded from the husk. This is the result of the second year's selection. On an adjoining plat of ordinary corn out of 50 ears only 6 protruded from the husks. In other words in the case of plat (*a*) 45.5 per cent. of the ears protruded, and in plat (*b*) 36.9 per cent. of the ears protruded from the husks, while in the case of the ordinary corn only 12 per cent. of the ears protruded, showing an increase in the first case, plat (*a*) of 33.5 per cent., and plat (*b*), 24.9 per cent. The husks on the protruded ears were finer, more soft and of less amount than that on the ears not protruding. Not only was this true, but the ears in the case of the protruded ears were better filled out and a larger and better formed ear than in the other case. Here, then, we have a tendency to a reduction of amount of husks, coarseness of husks, and a larger and better formed ear.

The second experiment was to select a variety with husks protruding over the ears. At the end of the season measurements were made of the length of the husks protruding over the ears in the case of the corn experimented upon and the ordinary corn. From an average of over 20 measurements, the following results were found:

Average length of husk protruding over ear on experimental plats—	*Average length of husks protruding over ear in the ordinary corn—*
$2\frac{2}{11}$ inches.	$1\frac{1}{2}$ inches.

In several cases the husk protruded over ten inches over the ear in the case of the experimental corn. We find an increase on the average of 9-11 of an inch or almost an inch as the result of two years' selection. We also found the ears to be decreasing in size, and the husks were harsh, coarse, and a great increase in the amount per ear.

Space forbids further detail of other experiments, but on the whole it can be said that Indian corn seems to be capable of a great amount of variation and that by selection we can perpetuate the variations so that we may be able to fix those variations which are favorable.

But we must now turn to the other division of our subject, viz: The effects of self-fertilization and of cross-fertilization in bringing about variations. We will consider first the effect of self-fertilization.

The plats allotted to the experiment were planted from seed which was selected last year, and which had been self-fertilized. These last year's plats were planted from self-fertilized seed of the year before or 1895, so that this year's crop has been grown from seed which has been self-fertilized for 1895 and 1896 and hence is of the third generation. The plats were planted by the side of ordinary corn, both the self-fertilized and the ordinary, being the Burr's White variety. All of the plats received the same kind of cultivation and attention, and were planted at the same time. The self-fertilized seed showed the effects of self-fertilization, being small, poorly filled out, in some cases each cob having only a half dozen well developed kernels. After planting, in about two weeks the ordinary corn began to appear, but it was five weeks before all of the self-fertilized appeared, and in many cases individual stalks did not grow until over six weeks after planting. Owing to the extremely favorable condition for growth during the early and latter part of the season, the self-fertilized became more uniform in size and appeared to be in fairly good condition. Following this season of rapid growth came an extremely dry and hot spell of over a week. The ordinary corn did not appear to suffer at all from the effect of the hot sun, but developed rapidly. On the other hand, the plats of self-fertilized began to turn yellow and the leaves to curl.

From this time the self-fertilized appeared to be checked and stunted and grew very slowly, if at all, until at the end of the season the difference in size between the self-fertilized and the ordinary was so great that the self-fertilized appeared to be some small variety. Along with the decreased height it was found that the stalks were correspondingly small and weak, the leaves narrow and of a pale yellow color, and the brace roots were poorly developed so that the stalks fell over and at the end of the season the self-fertilized plats looked as if they had been pastured and the stalks broken down by horses or cattle running over the plats.

It was also found that many of the stalks possessed what may be called for want of a better name, variegated leaves. This appearance was due to longitudinal stripes of a pale milky color and so predominant was this that it was found peculiarly in a plat of 32 hills, 25 out of the total 44 stalks bearing these variegated leaves. And later in the season it seemed that these stalks were particularly open to the attack of insect and fungus diseases.

At the time of the setting of the ears by the ordinary corn not one had appeared on the self-fertilized, and in fact it was about two weeks after the other one had set its ears that a single ear appeared on the stalks of the self-fertilized. Many of the stalks did not set an ear during the entire season and when the ears began to develop it was only very slowly and all were very small. Many did not advance beyond the first stages so that at the end of the season the percentage of barren stalks was very high.

As soon as the ears had developed slightly, closely woven cloth bags were tied over them so that pollen could not reach the ear from any outside source. In order to protect the tassel paper bags were tied over them so as not to interfere with its growth, and in order to preserve the pollen. As soon as the silks were ready for the pollen the paper bag was removed from the tassel, and while protecting the silk from the other pollen by a paper funnel some of the pollen from the tassel was dusted on the silk, the paper funnel removed, the cloth bag tied back over the ear and the paper bag replaced on the tassel. All this was done on a day when the wind was not blowing and great care was taken not to carry the pollen of one stalk to the silk of another stalk. In order to be sure of some of the pollen reaching the silks at the right stage of maturity this process was repeated four times and a careful record kept of the dates of pollination. This record was kept on a tag tied to the stalks and the dates recorded as seen in the illustration:

Plat 18—49.

Self-fertilized.

August 11.

August 13.

August 18.

August 20.

The resulting ears were small, of inferior quality and in many cases diseased. In no case were they ever larger than ordinary nubbins. It might be argued that this degeneration was a result of the *process*, and not of the self-fertilization. This is met by the fact that other corn, crossed in exactly the same method of procedure, did not show any evil effects of the process, but, on the other hand, were well developed and well filled out in every particular. As is a well known fact, corn in the natural state of cultivation is very probably cross-fertilized by the wind wafting the pollen about, so that in the natural state we get an actual cross.

The pollen of the self-fertilized was placed in a solution of sugar, glycerine and water, and kept in a dark and warm place. Nine watch crystals were prepared in this way and set away for twenty-four hours. Upon examination with the microscope it was found that only a few out of the great mass of pollen grains had germinated, and in two of the watch crystals none of the long threads of germination could be discovered. A smaller experiment was tried upon ordinary pollen and a surprising result followed. It seemed that every one of the pollen grains had germinated and sent out the long threads or filament so that the watch crystal was simply an interwoven mass of these threads. It would seem from this that the power of germination of the self-fertilized pollen grains was very weak, if not entirely lost in some cases.

An interesting comparison was made between the heights of the corn on the self-fertilized plats and the stalks on the ordinary plats.

The results are the averages of 14 measurements in each case, the measuring being done just after the growth had been completed.

AVERAGE FOURTEEN MEASUREMENTS.

	Self-Fertilized.		*Ordinary.*	
	HIGHEST IN HILL.	LOWEST.	HIGHEST IN HILL.	LOWEST.
Plat (*a*)..	5 ft. 11 in.	4 ft. 6 in.	8 ft. 5 in.	5 ft. 4 in.
Plat (*b*)..	5 ft. 11 in.	4 ft. 1 in.	9 ft. 1 in.	6 ft. 4 in.
Plat (*c*)..	5 ft. 6 in.	4 ft. 5 in.	8 ft. 5 in.	6 ft. 1 in.
Plat (*d*)..	6 ft. 1 in.	4 ft. 4 in.	8 ft. 3 in.	6 ft. 5 in.
Total av.	5 ft. 8 in.	4 ft. 3 in.	8 ft. 6 in.	6 ft. ½ in.
Total av .....Highest, 4 ft. 11 in.			Total av........Lowest, 7 ft. 3 in.	

We have here a total difference of height of 2 feet 4 inches in favor of the ordinary corn.

It is also interesting to compare the yields of the self-fertilized with the yield of the ordinary corn.

	Self-Fertilized.	*Ordinary.*
Plat (*a*)............	2 lbs.	20 $\frac{1}{2}$ lbs.
Plat (*b*)............	3 $\frac{7}{8}$ lbs.	22 $\frac{3}{4}$ lbs.
Plat (*c*)...........	3 lbs.	30 lbs.
Plat (*d*)...	2 $\frac{5}{8}$ lbs.	29 $\frac{3}{4}$ lbs.

From the foregoing facts we are led to conclude that the self-fertilized, in comparison with the ordinary or naturally cross-fertilized—

First. Weakened germinative power.

Second. Increased number of barren stalks.

Third. Tendency of stalks to lean, and later in season to fall over, instead of standing erect.

Fourth. Later maturity.

Fifth. Smaller ears.

Sixth. Increased tendency to decay in ear and stalk.

Seventh. Tendency to produce variegated leaves.

Eighth. Greatly increased height, size of stalk, width of leaf and total amount of foliage.

Ninth. Easily and seriously affected by hot, dry weather.

Tenth. An almost incredible decrease in yield.

In the matter of crossed corn, all that can be said at present is, that there seems to be a tendency to increase of yield during the first cross or so, at least. Corn is naturally cross-fertilized to some extent at least, as is proven by the fact that, if you plant yellow and white corn in adjoining rows, the result will be a mixed product, part of ear being yellow and the other part white. It is certain, too, that some variation is brought about by crossing.

Summing up, then, we may say that variation is possible with Indian corn, and that for the person who wishes to build up a type or improve an old one, there is an unlimited field for experiment.

EFFECT OF SELF-FERTILIZATION 1896.

EFFECT OF SELF-FERTILIZATION 1897.

HEALTH OF THE PIG.

BY DR. DONALD MCINTOSH, PROFESSOR VETERINARY SCIENCE, UNIVERSITY OF ILLINOIS.

Edmund Parks says: "If we had a perfect knowledge of the laws of life, and could apply this knowledge in a perfect system of hygienic rules, disease would be impossible. Hygiene is the art of preserving health. It aims at rendering growth more perfect, decay less rapid, life more vigorous, death more remote." So beautiful and comprehensive is this definition that it ought to be often repeated.

In dealing with this subject of health there are several things to be taken into consideration. First, we should follow Nature's steps as closely as practicable, and should consider the condition of the pig in its natural haunts, and deprive it of as few of them as possible. The pig is an omnivorous animal. It is destined by Nature to uproot plants and grope for food among the dropped acorns and other fruits of the forest; and Youatt says: "In point of fact, the snout of the pig is its spade, with which it roots into the ground for roots and earth worms." By putting an iron ring through the cartilage of its nose we thus deprive it of the power of searching for and analyzing its food, and by doing so we prevent it from getting substances which would be very beneficial for the maintenance of its health. To be profitable, it is necessary to feed pigs more food than they could obtain in a natural state, in order to bring them to maturity as fast as possible; and this is done at the expense of the animal's health. Seeing that this has to be done, we ought to consider what kind of food is best to obtain this result, and at the same time keep the animal in a vigorous condition. Yeo says that, "if an animal is in perfect health the pure alkaline blood circulating through the tissues of the body prevents the germs of disease from finding a suitable place to develop."

Let us look for a short time at the physiological actions of some

of the most important organs of the animal body, as we will then be better able to understand some of the causes of ill-health. The stomach of the pig, in its natural state, is small, and the intestines have great assimilating power. In this capacity the pig is ahead of all other animals, which accounts for its taking on fat so rapidly. By giving large quantities of food the stomach becomes distended and, in some cases, weakened so that it cannot digest the food properly, and it passes out of the stomach in this condition into the intestines, where it acts as a foreign body, setting up disturbance, deranging the mucous membrane, leaving it in a condition favorable for the development of microbes and other germs of disease; the indigested portion will pass out as feces. The pig should be fed as much during the fattening period as it can digest, and nothing more. This can be easily ascertained by examining the feces. The kidneys secrete the urine and other effete material, the result of the disintegration of the nitrogenous substances in the body; they require to be in a healthy, active state to perform this function, or blood poisoning is the result; if not blood poisoning, sufficient disturbance is caused to leave the animal liable to disease. The heart should be strong and vigorous in order to be able to propel the blood to all the tissues of the body to nourish them. The lungs should be strong, with large capacity to draw in oxygen and give off carbonic dioxide and other effete materials, in this way keeping the blood pure. The nerves, which govern all parts of the body, should be strong and active. This is largely accomplished by the kind of food we feed the animal.

What is the animal body composed of? The chemical constituents of the animal body may be thus classified: First, albuminous substances, characterized by the presence of nitrogen, carbon, hydrogen and oxygen. Second, carbo-hydrates and hydro-carbons, characterized by the absence of nitrogen and the presence of carbon, hydrogen and oxygen. Third, salts and water. In order to keep all the tissues of the body in healthy action and vigor, it is necessary to see that the animal gets a food which contains all these elements or to give a mixed diet which will combine to furnish the materials necessary. Food should be composed of nitrogenous portions called albuminates or flesh-makers; hydro carbons, or fat-makers, carbo-hydrates, which are starch and sugar bodies, also fat-producers. These are all necessary for the healthy development of the animal tissues. Let

us see which of the various grains contain the substances mentioned.

	CORN.	OATS.	PEAS.	RED CLOVER.
Water	13.9	13.5	13.8	16.7
Albumen	10.1	11.9	22.4	13.4
Fats	4.8	5.8	2.5	3.2
Carbo-hydrates non-nitrogenous extractive matters	66.8	57.5	52.3	29.9
Cellulose	2.8	8.1	9.2	35.8
Ash	1.7	2.6	2.5	6.2

These figures vary considerably, according to the ground on which the grains grow, whether it is rich or poor, cultivation, etc. The above table shows that oats and peas are more evenly balanced than corn. They are, therefore, the grains best suited for the growth and development of the tissues of the body, and also to keep them in a healthy state. When food substances are deficient in the albuminates and salts, the system is generally lowered in tone, and there is a tendency to the formation of "exudations," composed of imperfectly developed cells, which, in the great majority of cases, from the very beginning, are incapable of development into perfect entities, having only one potential quality, that of dying, and in so doing cause various derangements in the body, especially in the respiratory organs, producing tuberculosis and affections of the glands of the intestines. Oats also contain a nitrogenous alkaloid, called avenin, which possesses the property of acting as a nerve stimulant. It is on this account that horses largely fed on oats are so spirited. The salts or ash that these substances contain are all needed in the animal body in order that they will grow, and also support the system in older animals. Oats is the grain *par excellence* for the horse and peas for the pig. Corn alone has not sufficient albuminates and salts and has relatively too much starchy substance, which is converted into fat, and is therefore a grain which is not fit food for a young growing animal. It is necessary to feed other materials which contain albuminates to supply the deficiency of this material in the corn. I am satisfied that the prevalence of cholera among pigs in the corn-growing states is in a great part due to the feeding of too great a proportion of corn. In Canada, where the pig is mostly fed on peas, and oats and the refuse of wheat and rye, cholera is unknown. It is true there have been a few cases of cholera in Canada, but it has been mostly on

the borders where it was supposed to have been brought over the river, and some years ago at Montreal, supposed to have been caused by feeding on distillery slops. Messrs. Lawes and Gilbert made a number of experiments on feeding in England and found that pigs fed exclusively on corn would frequently swell in the neck. They did not wish to discontinue the experiment, and therefore resolved to try the effect of putting some mineral substance in a trough within the reach of the pigs. They made a mixture of twenty pounds of sifted coal ashes, four pounds of common salt and one pound of superphosphate of lime. A trough containing this mineral mixture was put into the pen at the commencement of the second fortnight, and the pigs began to lick it with evident relish. From this time the swellings or tumors, as well as the difficulty in breathing, began to diminish rapidly, and at the end of a month had entirely disappeared. The three pigs consumed of the mineral mixture described above nine pounds during the first fortnight, six pounds during the second and nine pounds during the third. This, although only a single experiment, shows, I think, that pigs may be fed on corn with impunity, providing that a compound of this or some other may be put within reach of the pigs.

I would suggest the following: First, that we should avoid inbreeding as much as possible, as there is no doubt that it lessens the vitality of the offspring, leaving them in a condition liable to disease. Second, that we select large sows, well developed and at least one year old. Third, that the boar should be of a smaller breed, compact, and of a vigorous constitution. This combination will insure strong, healthy offspring. Fourth, that the sow and boar should be fed on ground oats and bran mixed sufficient to keep them growing, but not too fat, as when they are too fat their vitality is lessened. They should have a small field to run in, separate, at some distance from each other. They should not have rings in their noses, but should be allowed to dig at pleasure, as they will find material in the ground useful for their health. If they should show signs of getting too fat, cut down their feed; on the other hand, if they are losing flesh, feed a little more. They should have a shelter from the sun in summer and a comfortable place to sleep in at night in winter. They should have green clover in summer and dry clover hay in winter. Give plenty of fresh water and a little salt mixed with their food. Pigs treated in this way will seldom have any ailments. Fifth, that having strong, healthy, young pigs to

begin with, it is necessary to feed them on materials that will keep up vigor and at the same time produce rapid growth. This can be accomplished by feeding them on ground oats or peas mixed with bran, and turning into a clover field if possible; if not, clover should be cut and brought to them. Milk of all kinds is useful. They should have a field to roam in, and after they are old enough the boars should be separated from the sows. The above food contains all the elements necessary for the growth and development of the pig. The bran, shell of the oats and the clover contain a large per centage of cellulose, and although the pig cannot digest more than half of this materfal, yet it is very useful, as it contains just what is needed to assist in forming the tissues of the body. Pigs fed as above will have all parts of their bodies well nourished and in a state of vigor to perform all the functions required of them to fortify the body against at least ordinary diseases. Sixth, that too many pigs should not be kept together, as they are apt to sleep in the same place, and although it may be well ventilated, or even out in the open air, they are apt to breathe some of the foul air emanating from their bodies. No class of animals thrive well where numbers are kept together. When the time arrives to feed hogs for market you will have a splendid foundation to begin feeding on; strong digestive and assimilating organs, which will be able to digest and assimilate large quantities of food. Corn can now be used with a little ground oats and bran with good advantage and profit. I think that if this were carried out, in a few years hog cholera would be a thing of the past.

CLOVER.

JOHN A. LATZER, CLASS OF 1899.

Botanically clover is classed with the Leguminosae, that is the bean and pea family. This is a large family of plants having nearly fifty different genera. All of our clovers come under the genus trifolium, which is characterized by the shape of the leaves. It has been stated that there are over two hundred known species of this genus found either in the old world or the new world. Some of the most common kinds of clover are: Common red clover, *Trifolium pratense;* Mammoth, *T. medium;* White clover, *T. repens;* Alsike, *T. hybridum,* and crimson Clover, *T. incarnatum.*

Trifolium pratense, our common red clover, is a native of Europe, and was known by the Greeks and Romans about two thousand years ago. It was early introduced into this country and is now grown in all or most temperate regions, to which climate it is very well adapted. It is a biennial or perennial, varying with the locality; but generally in this state it is a biennial. Clover thrives very well on drained prairie soils, especially those of the central Mississippi Valley. But it is grown as far west as the Rocky Mountains, and also to some extent in our southern states.

In all places where clover is grown it is found to be a very important forage crop, and for green manuring there is probably no plant that will ever take its place over such wide regions of the country. The specific uses of it are getting to be very great; too numerous to mention fully in this paper.

First, let us consider its value as a hay crop. We know that it is one of our most nutritive forage plants, as can be seen by examining the results given by the New Hampshire experiment station, on an experiment performed with some of the best dairy breeds. They fed the different cows on different foods for certain lengths of time, and thus found that during the period they were fed on clover the cows produced more milk and butter than when fed on any of the other foods.

It is probably known to all that it is a very difficult process to cure clover properly. Great mistakes are often made in not cutting at the proper time. This should be looked after for two reasons: First, when cut too green it takes a long time to cure, and it is exposed to rain and dew, or else it is put up too green and under such circumstances it is very liable to become musty. Such hay should not be fed to animals, because it is very injurious to the digestive organs, and besides it has very little nutrition. Some people recommend and practice putting hay up when yet very green and without much drying, but having seen very disastrous results from this practice I think it should not be recommended. Second, when cut too green it lacks in the amount of albumen, and on the other hand, when too ripe the parts that are otherwise nutritious will, to some extent, have been converted into woody fibre, which is, to a large degree, indigestible. It thus naturally follows that clover ought to be cut at the proper time, which is generally supposed to be when about one third of the flowers begin to turn brown. In order to get nice, bright hay it ought not to be soaked in a rain storm, and not even be exposed to dew, unless the clover has been cut shortly before and has not dried very much until thus exposed. Under such circumstances it will effect the hay very little or not at all.

It was formerly the belief that any kind of hay would do for cattle, no matter how it was cured or how it looked, but through advanced education and experiments it has been proven that there is a great difference. Although the effect is not so apparent with cattle as it is with horses, there is still enough difference to be worth looking after. Most people believe that clover will cause heaves in horses, but if the proper kind of hay is fed and in the right amounts there is certainly no danger from it. In feeding it should be remembered that two tons of clover hay have as much nutrition as three of timothy; therefore, one should feed accordingly. We have fed clover hay to our horses for the last fifteen years, and never had a heavy horse in that time. We feed little hay in the morning and at noon, so that the horses do not have to go to work after having gorged themselves with hay. In all this time we did not use as much hay as our neighbors, and our horses were in better condition to stand heavy work. I think there is danger connected with the feeding of clover hay to horses, from the fact that they like it so much better, and by letting them have all they want they will eat much more than of timothy.

We have now seen the value of clover as a forage crop, but its value for green manuring is still greater, for in this it has no equal. A crop of clover takes from the soil at least three times as much mineral matter as any wheat or oat crop and has more than three times as much nitrogen, which is the most valuable element as a fertilizer; thus when decay sets in we will have humus rich in nitrogen. The clover has also much longer roots than any of the ordinary crops and therefore brings up the elements of fertility from the deeper layers, and on the decay of the roots and other parts of the plant, leaves the top layers rich and in condition available for other crops with shorter roots; at the same time these long roots make the subsoil more porous and are thus beneficial in this way. It is mentioned above that nitrogen is a very valuable fertilizer. This is so from the fact that it is contained in very small quantities in the soil, but is essential to plant growth. It goes into composition in the formation of protied substances. Although this nitrogen is quite rare in many of our soils the air contains enormous quantities of it. The air is composed of about 79 per cent. of nitrogen and about 21 per cent. of oxygen. This nitrogen of the air is not directly available as plant food. Small quantities are washed down by rain and minute quantities in certain other ways. It was also supposed that clover had the power of absorbing or in some way utilizing this nitrogen of the air, but the most common belief was that it was absorbed through the leaves. To settle this question Lawes and Gilbert of England conducted some notable experiments* and found that the plant had no power to absorb any of it through the leaves or stem.

In 1886 Hellriegel†, and also the above experimenters later on, found that the clover plant did gain nitrogen from the air directly or indirectly, but not through the leaves and stems as formerly supposed, but through the roots. It was also noticed that in every case where nitrogen was gained the roots had tubercles or nodules, which are little enlargements on the roots, varying in size from a pin's head to a good sized pea. They have no regular shape and are situated in no definite position. After further investigation it was found that these nodules contained bacteria. The tubercles or gall-like‡ growths are caused by the bacteria or fungus entering the

*U. S. Bul. No. 22, Agricultural Investigation at Rothamsted, England. Page 122.

†U. S. Bul. No. 22. Page 120.

‡S. H. Vines. Text-Book of Botany. Page 713.

root through the root-hairs. They are not formed by the bacteria, but by the plant through the action of the bacteria.

The plant and bacteria appear to exist in a state of symbiosis, though recently it has been found that the bacteria can live without being in connection with a plant. If the fungus does live on or in the plant it does not in any way injure it, but on the contrary the clover gets the nitrogen which the bacteria got from the air and then converted into a compound such as is available to plants. It was also thought that the number and size of the tubercles vary directly as the amount of nitrogen gained. It is now believed that this is not the case, because in rich soil one finds many more tubercles. It is thought that some of the nitrogen is obtained from the soil, or from whatever source it is most readily available. This has been proven by A. C. Beal's experiments carried on here at the University for the graduating thesis in the spring of 1897. These tubercles appear not only on clover but on many leguminous and some other plants; most of the experiments have been performed on beans, peas and vetches. The bacteria occurring in these different species of plants are not the same, for one can not inoculate the clover with the bacteria found in the tubercles of the bean. But all of them are very similar and the work they do is almost identical. To show that nitrogen is gained by plants and in great quantities, we may cite the results of one of the above experiments. The soil was analyzed before clover was sown and it was found that the soil contained 16 pounds of nitrogen to the acre and where manured 27 pounds. The crop of clover in one year took off 300 pounds of nitrogen per acre*. This shows that nitrogen must have been gained from some source.

It might be interesting to explain how these experiments were conducted in the determination of this nitrogen question. They were carried on in pots filled with well washed quartz sand which was practically free from nitrogen. The seeds were then planted in this sand with the addition of some plant ash; a soil extract was then added for inoculation. This extract was made by taking one part of the soil and five parts of distilled water; after shaking up well the liquid was decanted off and about 25 cubic centimeters of this added to each pot with sand†. The experimenters found that the plants in the pots where none of this liquid was added made very

*Popular Science Monthly, Vol. 38, 1890. Page 499, *Article*—Progress in Agricultural Science, by M. Miles.

†Popular Science Monthly. Vol. 38, Page 492.

little growth and had no tubercles on the roots. Where the liquid was used the plants grew as well or even better than those in the pots which were filled with rich garden soil. The extract is usually made from the soil that produced a crop of clover the year before if the inoculation is to be used for the clover plant. It might be supposed that this liquid contained very much nitrogen, but in the analysis it was found that the amount contained in both the sand and extract would not produce a very large plant.

The application of "nitragin*" is now one of the new agricultural processes, introduced by Noble within the last few years. It is a pure culture of the bacteria from some of these tubercles. The bacteria must be alive and after a series of gelatin inoculations, a pure culture is received. Then a quantity is put into an 8-ounce bottle with some agar. It is claimed that one of these bottles has enough and of the right kind of material for inoculating one-half acre of plants from which the culture is made. It is applied to leguminous plants only. The cost of one of these bottles in Germany is 2m 5pf, in U. S. money amounting to about 60 cents. Voelcker found that pot experiments proved very successful; they were also tried in field experiments, but being rather late in the season when commenced were not as conclusive as they might have been. The results were as follows: Where inoculated there were more nodules than in the adjoining plat, although not very much larger growth. It is thought that the effects would be much more marked in poor soil where the supply of nitrogen has been exhausted.

The method of applying is, by moistening the seed and then adding the contents of one of these bottles; stir well so that it gets thoroughly mixed. It is then ready to sow. Another method of applying is to mix with sand or soil and then sow this mixture. This last method requires more labor and it is doubted if it is better than the other method. To get the best results the "nitragin" should be used as soon as possible after manufacture. It becomes worthless after being exposed to a temperature higher than that of the human body or about 100°F., also after being exposed to strong light for a considerable length of time. Already nineteen different kinds have been prepared, and if they prove to be as successful as they now seem to be, an advance will certainly be made in

*A full account on "Nitragin" in Journal of Society of Chemical Industry, page 767, Nov. 30, 1896. *Article*—Production of Inoculating Materials for Use in Agriculture. A more recent article in Science, Jan. 7, 1898, Recent Progress and Agricultural Chemistry.

the line of practical agriculture; for the material is cheap compared with other fertilizers, the method of application with seed taking very little time.

It is generally known that there is such a thing as clover sickness, but what it is and how it acts on the soil is not yet known. Storer in his book on Agriculture seems to think that it is caused from the want of potassium in the soil. In the Rothamsted experiments it was found that clover could not be grown in succession for very many years, on any soil; but other crops would grow well, even members of the leguminous family. We can thus easily prevent this derangement by establishing a rotation of crops in which clover does not come oftener than once in four or five years.

In seeding clover there is always a tendency to get it too thin or uneven, and then as a general rule the vacant spots will grow up in weeds. It has been recommended to sow from 16 to 20 pounds to the acre; if the conditions are favorable and the soil in proper condition this will be enough. In seeding it is well to study the field, and if there are any places in the fields where the soil is a little poorer, or if there is a ridge where there is apt to be washing, such places ought to be seeded heavier. When sowing by hand this can easily be regulated, but when sown with a machine such places ought to be followed up afterwards.

Another problem which confronts us is, what to use as a nurse crop, if any. In the southern part of the state, or where wheat is grown, it is the most common and probably the best nurse crop we have. It has been recommended to harrow the wheat field in the spring before seeding to close up the cracks which are formed during the winter, thus preventing the seed from getting down so deep. It is at present not known how beneficial this is, for it has not been experimented on to any great extent. Rye has been used as a nurse crop, but being a much faster grower checks the growth of the clover. In sections where wheat is not grown oats are often used as a nurse crop, but many prefer seeding alone. It has been found not to be very practical to sow alone, and by no means economical. Equally as good a stand can be secured, and often better, and from one-half to two-thirds crop of oats besides. In no case should a full crop of oats be sown when intending to seed with clover. A very important thing in seeding is, always have the ground in good condition.

One of the most interesting things in the plant world seems to

be the provision made by nature for cross-fertilization. In clover, as well as in many others of our flowering plants, it is necessary for insects to take part in the fertilization of the flower. If the structure of a clover flower has been carefully noticed it is readily seen that as an insect visits the flower it first strikes the pistil and then the stamens with the anthers. So when the insect goes from flower to flower after the nectar it cross-fertilizes them. As the tube in which the nectar is situated is very long the insect must have a long proboscis. The honey bee has a very short proboscis, therefore will not visit the red clover. The bumble bee with his long proboscis visits and fertilizes these flowers; it might thus be well to call him our seed maker.

APPLES IN ILLINOIS.

BY THOMAS J. BURRILL, PH. D., PROFESSOR OF BOTANY AND HORTICULTURE.

Illinois is rapidly becoming a great apple-growing state. I have not at hand exact figures, either of the total acreage in apple orchards or of the total produce of any one year. But the magnitude of this special interest must surprise anyone who for the first time travels through such counties as Marion, Jefferson and Wayne in the south central, or as Hancock, Adams and Pike in the western part of the state. These are special apple-growing regions, but other vast areas successfully compete with them either in the superiority or the quantity of fruit produced. It is indeed the exceedingly wide acreage suitable for commercial apple production that is destined to make Illinois the first state in the union in this, as in so many other respects. Probably nowhere else in the world are there in one body another 35,000,000 acres of land so well adapted to, and so favorably situated for the production of this king of all fruits. The horticultural development of our state has been reasonably rapid and has attained proportions surpassed only by that in a few of the allied commonwealths, and in not one of these few are there such magnificent possibilities for the future in apple-growing. It is true some choice is offered within our borders of soils and conditions most favorable for orchards, but apples can be successfully grown in more than four-fifths of our territory. Our state extends through five and a half degrees of latitude and there is considerable diversity of soil. It is evident that attention, as in the production of any crop, needs to be given to local conditions. Certain varieties of apples do better in the southern, others in the northern portions, and different soils require different treatment for the best results. We have large areas so peculiarly favorable for other rural industries, like dairying and corn-growing, that in them orchard interests are not likely to predominate. It is probable

therefore that while apple growing upon a commercial scale is entirely feasible throughout the state, there will be, as there now are, special regions devoted to this industry. The areas are to be large ones, surpassing for apples alone the entire horticultural acreage of most states whose great rural industries are of this kind.

Some statistics collected by Alvin C. Beal* for the apple crop of 1897 in a few of the counties of southern Illinois are of interest in this connection. A car load averages 160 barrels of 3 bushels each, or 480 bushels. There were shipped during the season the following number of car loads from the places named:

From Centralia, 387 cars.

From Mt. Vernon, 206 cars.

From Olney, 175 cars.

From Xenia, 153 cars.

From Alma, Makanda, Tonti, Flora and Salem, each, 100 or more cars, and from fifty railroad stations in these regions a total of 2,928 cars, or 1,405,440 bushels.

At two dollars a barrel of three bushels each this amounts to $936,960. It is easy to see what importance the apple crop assumes in the comparatively limited area covered by these statistics. For the state the total value of the produce of the apple orchards for 1897 must have been a very large sum.

The receipts per acre from the best orchards for the same year are also a matter of surprise to those not acquainted with the business. One orchard in Pike county netted its owner $200 for each of its 100 acres. Another in the same region just coming into full bearing produced over half that sum, and more than paid by its first crop for the land it occupied. These are large results, much above the average, yet not half what has been made from apples in Illinois, and not half what skillful growers in good locations may reasonably hope to obtain again. For the right men there are plenty of opportunities of money-making here at home in fruit-growing, and as more knowledge is gained upon the general subject, and better application is made of such knowledge to the special problems of treatment of varieties of local conditions, etc., fruitful years will be more frequent among the unfruitful ones. The business will become less hazardous, the results will be more uniform one year with another and therefore more inviting as a permanent

*Horticulture in Southern Illinois, a paper read at the State Farmers' Institute, held at the University of Illinois February 22, 23 and 24, 1898.

occupation for those educated for and in the business. The mere speculator better not make the venture at all. The most important factor in fruit growing is the man. It not only requires brains, but special aptitude and special information, as well as an alertness of observation and performance, for success in this as in every other skilled vocation or profession. The commercial apple-grower in Illinois may be easily able to carry along other lines of work, but whatever else he is or does he must be a specialist in this particular. He must be by nature and by training thoroughly adept and expert to secure reliable and large returns for the expenditures he is called upon to make.

What obstacles are encountered? Man is never exempt from the liability of disappointment. The best of us break upon unseen and undiscoverable snags and the wisest may fail to follow the path he thought he knew full well. It is not safe to say that there is only one or another particularized difficulty facing the orchardist; but, after making a survey of the field here in Illinois, it does seem that a reasonable hope for success can be entertained if some one or more of three things do not prevent. This, of course, on the assumption that the management generally is wisely planned and faithfully executed.

Perhaps failure comes more often through the direct or indirect effects of summer drought than from anything else. A whole train of injuries are liable to be so started. We hear much said sometimes of winter killing, but the winter is a dormant season. The tree simply needs resistance in its resting period. The normal activities of summer furnish this power; on failing so to furnish, the tree succumbs. With us injury to what we call hardy varieties—including all those now commonly planted in the different parts of the state—though apparently caused by cold, is assuredly to be traced back to the defects of summer's growth and preparation. In the main this again comes from the lack of water sometime during the season. We cannot control the rain-fall and irrigation is usually practically impossible. There is but one resource left. Fortunately this is sufficient—cultivation of the soil. If during the whole summer through the earth two inches deep is kept in a constant state of pulverization, trees will rarely suffer for want of moisture and will seldom fail to make a vigorous well-ripened growth, and to survive the vicissitudes of the hardest winters. Such cultivation is not usually practiced but must be thoroughly looked after by the

man who gathers the richest and surest harvest from the longest lived trees.

The codlin moth is an enemy which must be persistently fought. Wormy apples are practically worthless apples. The three well-known methods of destroying the insect should all be used, viz: Poisonous spray just after the fall of the petals, prompt gathering of fallen fruit by pigs or otherwise, and the use of bands around the trunks as traps for the worms. By these means it is entirely feasible to protect the fruit. This involves labor, but it is expense well incurred and not so great as to prevent large credit balances.

The third obstacle to be mentioned is the apple-scab fungus. The damages caused by this parasite upon the fruit itself are often very great. Not only is the appearance of the apples injured, but growth is impeded, the crop being reduced in amount as well as in quality. Few people understand, however, that still greater damage is done to the foliage of trees affected by this fungus. We see it conspicuously on the fruit; the leaves give evidence of its ravages no less certainly, but it requires closer looking to recognize them. The injury to the leaves, causing them to become hardened, curled, and at length ragged, strikes at the vitality of the tree and this in connection with an insufficient water supply is explanation enough for most of the evils observed. We are not without a remedy. The modern spray pump and Bordeaux mixture win the battle when effectively used. He who would grow apples in Illinois for profit must acquaint himself with this part of his business and must be persistent in the practical application of his knowledge. Spraying is a modern art based upon scientific observation and experimentation. He who would succeed best must work not so much by rule of thumb but through an intelligent understanding of what he is doing. Modern horticulture is in good part made up of brains.

An uncultivated and otherwise neglected orchard as seen on an Illinois farm.

A cultivated and otherwise properly cared for orchard as seen on experiment station grounds. "Domine"

HOW CAN THE ILLINOIS FARMER GROW HIS OWN FRUIT?

BY J. C. BLAIR, INSTRUCTOR IN HORTICULTURE.

Before going into a discussion of how the Illinois farmer can grow fruit for his own use, it may be well to consider the fact that he not only can but should do so. That he can produce fruit for his own use is proved when we recall that no state in the union has so many counties within its borders where fruit may be grown to advantage. In truth only two states possess greater or more varied horticultural capabilities. That the farmer of this state can grow his own fruit is also proven by statistics, which show that Illinois is the third greatest horticultural state—California being first and New York second. During the last fifteen months, while inspecting some one hundred and eighty fruit plantations and farms in forty-seven counties of the state, I observed with pleasure that nearly every farmer is growing a greater or lesser quantity of fruit; the only difficulty being that he is too often indifferent to its importance and does not know how to improve what he does grow.

That he should grow his own fruit is a question needing no discussion here, since every one is aware that that man is the happier and more contented, that family the healthier, on whose farm is grown a liberal supply of fruit for the table. But because one can and should do a thing does not prove conclusively that he will do it, or that doing it he will do it well. The farmer may not understand the principles of fruit culture, or he may be producing it at a needless expenditure of time and labor. Too often we find him attending to the other operations of the farm and leaving the fruit plantation to take care of itself, or at least attending to it only in his leisure moments. Even the setting of the plants themselves is often left until so late in the season that they either die or make but weak growth.

The first and most important point for the Illinois farmer (or any other) to consider when giving up a portion of his farm for fruit, and one which is often wholly neglected, is the selecting of varieties suited to his locality and the selection of a suitable site in which to plant them. These points are personal and unique for each individual farmer. He it is who must decide just what variety will do best, although it is an aid to such decision if he consults with the fruit growers of the neighborhood, the horticultural society reports and state experiment station.

Granting that the farmer has successfully passed this preliminary stage and has chosen the varieties best suited to his needs, the next step is to prepare the soil for the reception of the plants, and the thoroughness with which this is done will usually determine in great measure the results obtained. Proper cultivation of the soil has been too often overlooked by not only farmers but horticultural people. If in this early preparation he can subsoil the land very much will be gained, for the roots will be enabled to go deeper and will suffer less in time of drought. If the land is naturally heavy with a stiff, tenacious subsoil, it should also be tile-drained. Even if the land is subsoiled it must be plowed deeply, then thoroughly pulverized with disc and smoothing harrows. It will pay to make the first preparation of the soil very carefully. When the young plants are set they should be as deep as they were in the nursery or perhaps a trifle deeper. Set the apple trees at least twenty-eight feet apart in the rows, and let the rows be the same distance apart. This may vary somewhat with the varieties. The distance that other fruits are separated will vary with kinds, but not to any extent with the varieties. The entire fruit plantation should be thoroughly tilled each season during the growing period. This will increase the amount of available plant food and conserve the soil moisture. With most fruit crops a hoed crop can be occasionally grown in the plantation or short rotations practiced; but in no case allow the weeds to have their own way, or leave the plantation in sod more than a year or two. Healthy fruit plants, the ones which are least subject to insect enemies and fungus diseases, are the ones which have received the best cultivation and have the best foliage. The orchard trees and small fruits require the same care in cultivating as do our corn crops, if good results are to be obtained. The two plates herewith illustrate the importance of this matter of cultivation and proper management of orchards.

In regard to fertilizers, little need to be said for this state, except to call attention to the fact that young and growing trees require plenty of nitrogen (but not an excess), while the fruiting trees should be well supplied with potash or phosphoric acid. It is very essential, however, that during the fruiting season of even the large trees, they have an abundance of water which will carry plant food in solution into the tissues. Good cultivation gives this.

The operation of pruning is for the purpose of thinning out the superfluous branches, thus giving the remaining ones a chance to develop and mature their fruit. It is not wholly an artificial operation, for nature is a most vigorous pruner. The plant must not be considered as an individual, and where a member is removed that it is thereby injured, but rather the plant is a collection of individuals each struggling for a place, and when man interferes and removes certain of these the tree is thereby vitalized rather than devitalized. All fruit trees and small fruits should be liberally pruned each year, beginning the year the plants are set out and continuing throughout their lives. In this way the amount to be done each year is small in comparison with what it would be if left for several years.

The next and fifth point which the Illinois farmer must consider, should he wish to be successful in growing his own fruit, is that of spraying his plants for the purpose of protecting them from the insects and fungous diseases. Every farmer who attempts to grow his own fruit will probably have to fight the codlin moth and some of the other insects and the apple scab or some other fungous disease. In order to do this he must provide himself with a hand spray pump, which, when attached to a barrel and mounted on a wagon and provided with hose and nozzles, will be found ample for applying the requisite solutions to the foliage of the plants found on the average Illinois farm. This, with Paris green for controlling the chewing insects, kerosene emulsion or whale oil soap for controlling the sucking and scale insects, and Bordeaux mixture and copper sulphate for controlling the fungous diseases, is usually all that is required. Having provided these and being persistent and thorough in the applications of the solutions, success will be most certain to attend all efforts.

In concluding, let me repeat that the Illinois farmer not only can, but should, grow his own fruit. How he can do this I have but briefly stated, allowing the minor details to take care of themselves.

The harvesting and marketing are important matters for consideration when growing for commercial purposes, but need no place in this discussion.

HORTICULTURE FOR FARMERS.

BY E. A. RIEHL, ALTON, ILL.

Every farmer ought to be something of a horticulturist. Horticulture is the fine art of agriculture. The more of a horticulturist a man is the better farmer he will be, the better will be his home surroundings, the better will he live and the more content will be his children with farm life.

Too many farmers think only of their crops and live stock, the money they can make, and too little of home life and their surroundings. I know that time and money spent in beautifying the home grounds is as good an investment as a man can make. Nor need the expense be at all great. In fact much can be done without expense except to give a little time and thought to it. Take the matter of home ornamentation in the way of ornamental plantings. If a little money for that purpose cannot be spared, much can still be done by gathering from the forests such trees and shrubs as may be found there and planting about one's home in proper places. We have no finer trees for such purposes than the elms, oaks, maples, lindens, etc., and among the smaller trees what is a prettier sight than the Juneberry, dogwood and redbud when in bloom in spring? Many plants, shrubs and trees can also be procured from one's more fortunate and well-to-do neighbors. Lovers of horticulture are generous and will be glad to give freely of what they have, both in the way of plants and advice in the matter of what to plant and how to care for such plants. The ornamental plantings on the farm should not be confined entirely to the immediate surroundings of the house. The aim should be to beautify the whole landscape. By this I do not mean to say that any large or tillable part of the farm should be given up to that purpose. There are on nearly all farms spots not well adapted to cultivation. Such can, at least in part, be devoted to a small clump of trees, either for timber or nuts, or evergreens. Our country could be much beautified

by such plantings, and what delightful picknicking spots these would make for the younger generation. All farms should have some nut trees. More can be done in the way of growing nuts than many are aware of. I have growing on my place walnuts, hickory, chestnut, pecan and almond, all in bearing from trees planted by myself. Evergreens add much to the beauty of the landscape, especially in winter, and need cost but little as small trees can be bought very cheaply. Planted as single specimens near the house and in groups or small groves at a distance, but in sight of the house, they add very much to the beauty of the landscape. Such plantings can be made in ravines or on steep hillsides; on prairie farms, where there are no such waste spots, groups can be planted in some corner of a field near the public road or in a pasture. Live stock will not usually injure evergreens.

Every country home should have a lawn about the house, which should be kept properly trimmed with a lawn mower. These machines are now so well made and are so cheap that no one wishing a good lawn need to do without one. A good lawn cannot well be had without their use.

Few farmers give as much attention to furnishing their families with a good supply of vegetables and fruits as they should. It is everyone's duty to provide his family with them, as they add greatly to the health, happiness and contentment of those dependent upon him. Were farmers' homes better supplied in this respect, they would have less doctor bills to pay, live cheaper and they and their families would be better physically, mentally and morally.

Those who have not been in the habit of providing these things have an idea that it takes more time and money than it really does, nor can they appreciate the benefit that it will be to their families. If such would but take a mental survey of their neighbors they will invariably find that those who have the brightest, most moral, and best contented families are those who have the best home surroundings in these respects. And on the other hand I think it will be found that the rough boys who prowl around at nights, get into all sorts of scrapes, pull up and destroy melon patches, throw down fences purposely, leave open gates and place obstructions in the public highways, thinking these tricks smart and great fun, are invariably the sons of parents who live in homes devoid of the home surroundings of which I have spoken.

Is it then the duty of everyone owning a home to make an earnest

effort in this direction? I think so, from every point of view. It is better for ourselves, our children, and the community in which we live; and I am sure it will pay in a financial way. We and those about us will be better farmers for it, and being better content with our lot will work with a will and vim impossible when we are discontented and are looking with envious eyes upon those in other walks of life, whom we believe to be having an easier and pleasanter or more profitable time. This should not and need not be true. The farmers of this country can and should live better, healthier, happier, and more independent lives than any other class of people in the land. That the majority do not is their own fault. They do not live up to their privileges and the possibilities of their calling.

THE SCIENCE OF AGRICULTURE.

BY H. S. GRINDLEY, SC. D., ASSISTANT PROFESSOR OF CHEMISTRY.

It can be truly said that today there is a science of agriculture. Such could not have been said many years ago. Much has been done by half a century of persistent and intelligent effort to advance our knowledge of the facts and principles upon which progress in agriculture must proceed in the future. We have men who have devoted their lives to the cause of agricultural science. They have made a remarkable and lasting impress upon the agriculture of the world.

The science of chemistry, botany, physiology, zoölogy, entomology and geology have all assisted in the work of developing the science of agriculture. Without doubt of all the sciences that of chemistry has done the most for agriculture. From the earliest times it has rendered valuable assistance and it is still working wonders in the line of results which are of value to farmers.

Although it can truthfully be said that there exists a science of agriculture, it can also be said with as much truth that many of the farmers of our state and of our country do not understand and therefore are not applying the principles of the science which have been discovered with so much labor, thought and expenditure of money. The farmers of our country and the country itself are the losers thereby.

Undoubtedly several of the European countries, notably Germany, Belgium and England, are taking the lead in scientific farming. This is to a certain extent at least to be expected, since it is absolutely necessary for them to do so in order to compete with our cheap land. As a result of this competition they have given much attention to the subject of scientific agriculture. We must not allow ourselves to be left behind in this most important occupation of many of our people. The farmers of our land must avail themselves of the knowledge which will place them in the lead. They

must make the proper application of what is now generally known and accepted by those who are leaders in agriculture.

The experiment stations of the United States are able and willing to furnish the knowledge. Our farmers must place themselves in a position to understand the important discoveries in agricultural practice which have been wrought out by hard work extended over a long period of time. However, these principles, now that they have been discovered, are comparatively simple and easy to understand and will be of untold value to the farmers, both from a financial and intellectual standpoint. The growth of population, the requirements of intensive farming and the increasing pressure due to the competition in all the markets of the world for the sale of farm products, necessitates that the farmers of this state and also of the United States should early consider what is necessary to bring and to keep them prominently in the front in the practice of successful agriculture.

As population increases in proportion to area there arises the necessity for increased production over a given area. The time is not far distant when it will be impossible for a man to undertake farming successfully except upon scientific principles and with considerable knowledge of chemistry and kindred sciences as applied to agriculture. In fact, this is largely true today in the countries of Belgium, Holland, Germany and England.

For the time being this object may be at least partially accomplished by the farmers making free and liberal use of the educational opportunities now available. Of these we may mention the farmers' institutes, which are now in a condition in this state to do much good in imparting to the farmer that which is of value. There is much to be learned by a body of farmers at a good institute. It is the source of scientific knowledge and a place where, by conferring together, better methods of work are evolved. During the institute the leaders of research and of instructors in agriculture should always be heard from.

We have also the experiment stations, the knowledge of which is readily available to all farmers who wish to improve their stock of information and methods of work. From the publications of the different experiment stations and those of the department of agriculture the farmers can keep in touch with the researches of this country and of Europe in the line of agriculture. It will be possible for them to adopt that which experimental work has proven will be

of value to them. In this same connection the farmer should avail himself as far as possible of the information given by the publications of the agricultural press and of the State Board of Agriculture.

Further, we have the agricultural colleges, which should be made one of the chief factors in educating the farmers of the coming generation. Throughout this state of ours there are many young men and women of the farm, who are well able to take two or three, or even four years' time in the study of agriculture and the sciences. Such a study would give many of them an entirely new view of life and at the same time impart to them information which would fit them much better to successfully follow the practice of agriculture and make better and more useful citizens.

Too many of the fathers and mothers from our farms fail to realize the advantages which they could easily afford to give their children by sending them to the University. To the young mind there is much real pleasure and enjoyment in the study of science. In the study of any science we see new things, beautiful and interesting truths, and to those who choose to go deep enough, immense fields of undiscovered precious truth are laid bare. These facts, these studies all have a good influence upon the young mind and give to it development which will at all times be of much value in after life.

As a result of the advances in the science of agriculture, let us look at a few of the many ways in which science may be of service to the practical farmer of today. The first attempts to improve the practice of agriculture were devoted to the study of the soil, the field of the farmer's labor. The question of soil fertility is one of great importance to the practical farmer. In this study chemical analyses were first made and the composition of different kinds of soil was determined. However, after much investigation it was decided that it was seldom possible from simple chemical analysis of the soil to determine what fertilizer it would be best to use.

This study led to another one of much importance and one which has given valuable results. That is, it was necessary to determine what fertilizers were required for the best development of different cultivated plants. This determination of the fertilizer requirements of crops took much time and many long and difficult experiments. However, as a result of these lines of research, it is now known what substances can be made to yield valuable plant food, and it is also known how they should be used in order to give the best results. It is now possible to determine for the farmer the

fertility of his soil and to inform him exactly what fertilizer it will be best to use upon his soil for the crop he desires to grow. Are the farmers making the best use of the knowledge here indicated?

Again, cannot the practical farmer maks further and better use of the principles and laws regulating the feeding of farm animals? The rational nutrition of the live stock of the farm is equally as important to agricultural production as the rational use of fertilizers. Within the last twenty-five years much has been discovered by the experiment stations of England, Germany and the United States in the methods of feeding animals. It is now possible to calculate rations with comparative certainty as to the results which will follow their use. As a result of using rations calculated by the experiment stations in Germany, the milk production has, in some cases, been increased one and one-half quarts per cow daily, without materially increasing the cost of the food.

THE DAIRY HERD FOR THE FARM.

BY H. B. GURLER.

I believe it can be easily proven that there is more room for improvement in our dairy herds and their managment than there is in any other line in the whole field of agriculture. When we stop to think that the average make of butter per cow in the United States, as reported by the last census, was 130 pounds per year, we are surprised. When we put this fact by the side of the thoroughly practical one that it is possible to have our dairies produce an average of 300 pounds we are still more surprised. There are many dairies in the United States that produce more than 300 pounds of butter annually per cow. There is not the least doubt of the practicability of securing dairies that will do this grade of work. There was a dairy selected for the Illinois Experiment Station a few years ago that, as I remember, exceeded the 300 pounds work, and the cows were obtained in the vicinity of Urbana and Champaign. There are plenty of cows scattered all over the United States that will do this quality of work when intelligently handled.

We do not employ men who can not do more than to earn their board, neither do we keep work horses on our farms that can not pay for their keeping. There is now no business sense in keeping cows that do not pay a profit. With the scale and Babcock test we can easily tell what the cows are doing for us, and when we know the cows that pay the profit and those that are making a loss, it is easy to settle what to do. We must treat the unprofitable cow the same as we do the unprofitable man or horse, i. e., get rid of them, and it is much easier to get rid of the unprofitable cow than it is the unprofitable horse, as we can fatten the cow and sell her for beef. Thirty years ago, before I engaged in the dairy work, I looked the field over with what intelligence I could command. This fact seemed to stand out plainly everywhere, i. e., all sections that had been in the dairy business for a term of years were prosperous.

This, I am confident, will always be found to be the truth. There is one prominent reason why it will continue to be so. That is, persons will not submit to the close attention the dairy demands unless it pays better than other lines of farm work.

I shall not undertake to tell any one what breed of cows to select. They must be governed by the conditions that surround them. The individuality of the animal is of much more importance than is the breed. There are excellent cows in all the dairy breeds. For my locality I believe in the special purpose cow, the milk and butter kind. Under other conditions I presume I might want the general purpose cow, or the beef and butter kind. I shall not quarrel with anyone along this line, but I will quarrel with the man or woman that does not look after the individuality of his cows. If they were in the manufacturing or mercantile business they would soon have their creditors looking after them and pretty sharply, too.

I do not understand why we do not use more business judgment and sense on our farms. There certainly is room for it. A farmer in many parts of Illinois who owns 160 acres of land with good improvements and well-stocked has invested $15,000. This is sufficient to command a man with business ability as manager and when such managment is secured, the farm will pay. There is not the least doubt on that point. My experience teaches me that a cow must make above 200 pounds of butter per year to be profitable. The more a man has of cows that produce less than that amount the worse he is off, if he is obliged to keep them or does keep them without knowing their merits.

Why so many dairymen continue to keep such cows I cannot understand. It is no better than trying to plow our prairie soil with a cast iron plow, or to cut our grain with the cradle, or to thresh it with the flail.

There is one line of dairy work that we continue to perform in the old way, that is milking. I suspect we shall continue for a time yet to do our best work in the old way. It is, I am confident, a fact that the human hand, next to the calf's mouth, secures the best results in extracting milk from the cow's udder. With the scale and Babcock test it is a simple matter to learn what each cow is doing. There is no work on the farm that will pay as well as this work will, for in a few years the unprofitable cows will be discarded. The net profit of most dairies will double, even thribble and quadruple in many cases. When we have learned what each individual

cow is doing for us we are in shape to do intelligent work in breeding, and we cannot do it before. The bull is one-half the herd, hence great care should be experienced in selecting him. Do not let a few dollars get in the way of securing him. Look well after the butter record of his ancestors.

I raise my heifer calves on separator skim milk. I now have 24 on my farm that have been fed that way the past winter and disinterested persons say they are nice ones. Many persons seem to think that because the cream is taken out of the milk the calf must be fed a much larger quantity. This is a mistake. Too much skim milk causes a diarrhoea, and if it is not checked serious trouble follows. The milk should always be fed to the calves at the temperature of the mother's milk, or 100 degrees Fahrenheit. Many calves are ruined by being fed cold milk. I prefer to have my heifers drop their first calves at two years of age. I believe I secure better cows by this practice than I do when they are three years old when they become mothers.

Be careful to milk the heifers as long as ten months if possible after their first calf. This helps to establish the milking habit. The only way I have succeeded in disposing of unprofitable cows without loss has been to fatten while being milked. After a cow has been milked two or three months and fed well she will take on flesh and can be gotten in condition to sell for beef as soon as she is dry.

The question of feeding cows is one that is not given the intelligent thought that its importance demands. We all know that the cow must first take care of herself, support her own system, after which, what food she consumes is returned to the owner in the milk pail. There is no more profit in feeding a milch cow just enough to "hold her own" than there would be in firing a steam boiler so as to just keep the water boiling, but secure no pressure of steam to operate the engine, in which case all the fuel would be thrown away and also the labor of the fireman.

Why do we, so many of us, continue to do such foolish, unbusinesslike work? I use the term "we" purposely, for I am a dairyman myself, and am now milking at Clover farm 135 cows and have also 63 dry cows and calves, making a total of 198 head of cattle on my farm. I keep the weight of each cow's milk daily and test it periodically, so that I have a basis upon which to figure her profit.

In feeding cows the point that most frequently attracts my

attention is the palatability of the food. Food may contain the proper constituents, may be perfectly "balanced," and yet if it is not palatable the cow will not consume sufficient to pay a profit. My experience teaches me that a palatable food is an easily digested food, as a rule, for the loss of palatablity comes most often from the fodder being allowed to become over ripe before it is cut and cured.

The cow and the chemist may not always agree as to the value of food, in which case I do not consider it any reflection on the chemist to stand by the cow.

A large percentage of dairymen commence cutting their hay too late to secure the best results when fed to cows.

Clover should be cut when in full blossom. Let us not blame the cow for not being able to overcome our mistakes, but let us study our cows and learn to understand their wants.

I have never been able to bridge over the mistakes I have made in not securing the best hay or silage for my cows. An increase of ground feed will not accomplish it, but it will increase the cost of feed in the west where the coarse fodder is the cheapest or most economical food so far as it can be used.

I shall say but little about the silo. I have had about fifteen years' experience with ensilage and my faith is growing yearly. I never before was so strong a believer as now in its value. I built three new ones in 1897, that contain 250 tons each. They are built circular, and are plastered inside with Portland cement. Sound silage is all right. The greatest stumbling block in connection with its use has been from feeding unsound silage caused by faulty construction of silo, or from too long exposure to the atmosphere before being fed. This exposure in many cases comes from the compartments being too large for the number of cattle fed from it. Six surface feet per animal is a safe rule in building, to eight surface feet should be the extreme limit. More than that will allow too long exposure, and decay will follow, which always brings trouble when fed to milch cows. *Any kind of decayed food effects the milk.* I beg you not to forget that point. I practice warming water for cows in cold weather, believing it pays in an increased product and also in insuring better health to the cow.

I am confident that a cow will produce more milk during her milking period when she comes fresh in the fall than she will when she freshes in the spring. I prefer fall calves to raise, to spring calves. I can give the youngsters better care in the winter than I

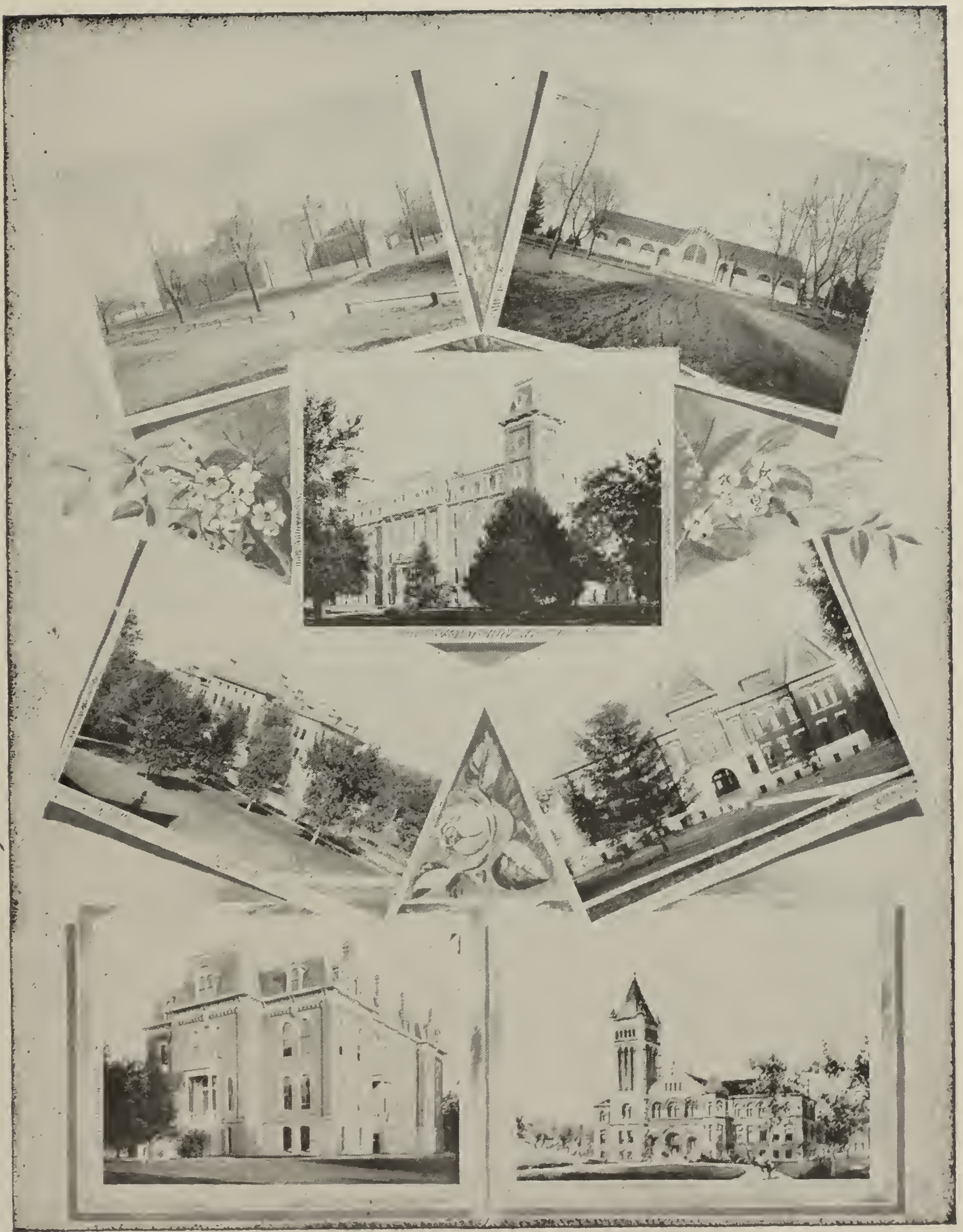
can in summer when we have the heat and flies to contend with. I know it is best for the cow to go dry in the summer on grass and have no grain food. This renews her and she will not "wear out," as we hear men say. I find my cows remain profitable under this management until their teeth wear out. I do not know of any method of preventing that.

Cow stables should be well-lighted and ventilated. They should have as good a system of ventilation as we would put into our own home. We must solve this among other problems in the near future. The intelligent consumer is soon going to demand it, in fact, is demanding it now. We consume more filth in our milk than in any other article of food. The German, Dr. Backhaus, who made a thorough examination of the milk supply of the city of Berlin, closed his report by saying that the people of Berlin consumed in their daily milk supply 300 weight of cow dung.

What wonder that milk has cowey or animal odor! Will we ever learn to be clean in our work with the cow? We will when the consumer forces us to, and that time is not far in the future, for which fact I am thankful.

I am a firm believer in dehorning my 25 calves that are being raised this winter and all have their horns killed. I believe this to be a humane act. The cow with horns causes more pain to her neighbors than the removal of them causes her.

I wish to talk a little about milking. The importance of this work is but poorly appreciated. A poor milker causes his cows to shrink in their milk very much, in fact the milker may destroy all the profit of the cow when all other points are right. Some milkers are worth $25 per month when others are worth nothing. I have facts of my own to prove the above. It is not guess work. Some men cannot do good work, no matter how hard they try, others can, but will not. There must be a kind feeling between the milker and the cow to secure the best results. The cow will not respond unless there is. Old Dame Nature is curious and must be humored. She will not be forced to do her best. Here is a great field for thought, both in the cow family and the human family, and let us not get above applying what we learn in one family to the other.



STUDENT LIFE FROM A STUDENT'S STANDPOINT.

BY LOUIS D. HALL, CLASS OF '99.

When placed side by side in college with the polished young man from the city or town, country boys are very likely to feel that they are handicapped and that the toil and restraints of the farm have narrowed their capabilities and prevented them from making proper preparation for college life and laying a solid foundation for a college education. My observations since entering college, however, have taught me that this notion is a wrong one, and that an industrious boy from the country who has had reasonable advantages at school need in no respect feel inferior to the average city boy of the same age who has been in school an equal length of time. In fact, I frankly believe that as a rule the country boy comes to college with a broader mental development and a better rounded character than the young man from the city, and that, other things being equal, the chances of highest success in college are in his favor.

A second error which I have found to be very common among country boys who enter college is the choice of a course of study without having given the matter sufficient reflection and forethought. In my own case, like many others, I took up a course in mechanical engineering, partly because I found considerable fascination about it and partly for the reason that so many others were entering the same course of study. I devoted two years of my college life to the study of engineering and then began to be impressed by the significant fact that although the present field of agriculture in our country is incomparably broader than that of engineering, and while agriculture in its true sense undoubtedly requires just as thorough an education as engineering, still the young men who are now studying agriculture as a profession bear a very small numerical ratio to those in our schools of engineering. This does not

prove that every young man should at once begin the study of agriculture, but it certainly does mean that every country boy should train and educate himself for the management of the farm, unless he has a particularly good reason for following some other line of work. Says President Finley of Knox College: "A profession demands a reason of a man before he shall give it over." Agriculture is coming to be a profession, and the prominent man in the dawning century will be the land owning farmer who thoroughly understands his business.

The agricultural student, as well as college students in general, must keep from growing narrow and from becoming so engrossed

with his particular line of work that other essential things are overlooked. I may mention, therefore, a number of influences that I have found in my college life here which help the student of agri culture to avoid this tendency toward one-sidedness.

In the first place, our agricultural course has been laid out upon a broad plan. About one-third of the student's time is devoted to technical agricultural studies, another third to subjects of general information and the remaining third may be utilized for any line of

study that the student may select. This plan is followed through the four years of the course, thus making it both general and specific. By choosing his elective studies along the line in which he is particularly interested, whether it be animal husbandry, horticulture, dairying, chemistry or even literature or art, the student becomes both a specialist and a broad man. Of course most of our agricultural students direct their elective studies toward some phase of agriculture and thus improve their valuable time at the University by gaining the knowledge which will be of actual and practical value upon the farm. When the University of Illinois was founded, "Learning and Labor" was chosen as a motto; and it is still proposed that the student shall combine the education of the hand with that of the head, practice with theory, labor with learning. The instruction is quite largely by laboratory and field training, while our work in recitations, lectures and library develops the theoretical part of our education

Then, too, as the agricultural student here is placed among a thousand men who are studying along lines different from his own, as he comes in daily contact with people from all parts of the country who have traveled, studied and observed, his views are gradually and almost unconsciously broadened, one by one the barriers of narrowness are broken down, and when his college course is completed he stands at the center of a rapidly widening horizon. This is one of the most important factors in a college education.

There are several organizations in the University which I have found to be of great help, also, in my agricultural studies. The Agricultural Club is composed of students and instructors in the College of Agriculture and others in the University who are interested in agriculture. At our meetings, those questions are discussed which have direct bearing upon agriculture as a business, and scientific and theoretical principles are applied to the practical problems of farming, stock-raising, horticulture, dairying, etc. The literary societies, also, are of great importance to the agricultural student. There he learns to speak and think readily before an audience, write naturally and present his thoughts clearly and easily to others. Next in importance to knowledge itself is the ability to impart knowledge to others, and the literary societies give excellent training for this by means of debates, declamations, papers and orations. Thus far this year three of our agricultural students have won honors in debating and declamation contests at the

University, which shows that the influences of the farm are not entirely deteriorating. The religious associations, political clubs, musical and other organizations of the University give the opportunity for development along other important lines, and the agricultural student is usually quick to avail himself of these advantages. It has been recognized, too, that physical development should constitute no small part of the college training of the agricultural student. Every college takes a great deal of pride in her athletic teams, and certainly the number of country boys and agricultural students who are becoming prominent in inter-collegiate contests proves again that the young man from the farm is not unfitted to compete with the city-bred youth.

The influences which surround the agricultural student, then, as I have tried to show, are uplifting and broadening; and if, at the end of his college life, he remains a narrow man it is because of his inherent nature and is not due to his environment. But college life is not, nor should it be, all toil with no pleasures. Vacation comes to vary the routine of the students' life, and as he leaves his college work for a time and returns to the old farm, the farmer-boy realizes, perhaps for the first time, that "There's no place like home."

SWINE BREEDING AND FEEDING.

BY A. J. LOVEJOY, ROSCOE, ILL.

Ever since the earliest recollection of man the growing and feeding of hogs on the farm has occupied the attention, to a greater or less extent, of the general farmer. In our earlier days but a few were grown on the average farm, and these were usually of uncertain origin as to breed. They seemed to be part scrub and the rest just hog. They were confined to a small enclosure or closed pen during their entire existence, fed on the various refuse of the kitchen, and at the age of about two years were finished up on corn, and during the early "cold snap" of the winter were slaughtered adjoining the pen where their lives were spent and strung up on a pole to "cool out." Then what was not wanted for home consumption in the farmer's family was loaded on the wagon and hauled to market, which in this country meant either Galena or Chicago, and there brought the magnificient sum of 2 to 2½ cents a pound, dressed weight. We who live in the present day and generation often think we have hard times, but little do we know about real genuine hard times, such as our fathers who settled the broad prairies of Illnios in the early days had to pass through.

I have at home the old coffee mill that my father used the first years of his life in Illinois, in 1837, in which he had to grind corn to get meal to make corn bread. There were no custom mills and no wheat flour. This was but one of the many hardships of those days, so let us say no more of hard times.

The hog has kept pace with the march of civilization in all countries and has without doubt been a source of more clear profit to the American farmer than any other class of live stock kept on the farm. There may be instances where the dairy cow has possibly proven more profitable, but this was not by the general farmer, but by a specialist or an expert dairyman, which should not be here

considered, for I am talking more of the *general* or *average* farmer. If I were not I might cite you to specialists in the breeding of pure-bred herds of swine, who by hard work, close attention and strict business principles, have built up a successful and profitable business that possibly might make a dairy cow take a back seat.

What kind of hogs should a farmer breed to make the most money? The breed should be any of the well known leading ones that happen to strike his fancy. They are all good when properly handled. There is just now a great "howl" going the rounds of the papers about "bacon hogs," some even going so far as to recommend the original "razorback" and the "Tamworth," which are own cousins to the "razorback." It seems to me simply ridiculous to consider this question of changing breeds entirely to produce fine bacons and hams. Better by far change our system of breeding and feeding. Instead of breeding year after year from immature animals and feeding nothing but corn, corn, change our methods, breed from mature animals. When you find that you have a sow that is a good mother and produces large, even litters, keep her as long as she lives. If she ever has the cholera she will be much more apt to survive than a young sow, and once over it, she is worth her weight in gold, for she will never have it again. We have such a sow now, in our herd of Berkshires, that is in her thirteenth year. This is pretty old, but I copied a clipping which knocks us clear out. It is as follows:

"A sow forty-three years old, belonging to Taylor Brothers, Lynchburg, Tenn., died recently. She had been in the Taylor family all these years. She was of the big-boned Berkshire breed, was cholera proof, and had not been sick for over a quarter of a century. She had raised 800 pigs, from which enough money had been realized to buy a good farm. She was buried on the farm and a stone was marked and placed on her grave." So much for using mature animals. They no doubt produce stronger pigs, more of them, and less liable to disease.

How can the Illinois farmer produce a better quality of bacon and hams? He can do so by selection of his breeding animals. Select the longer, leaner type. Then feed little, if any, corn, using the other grains and grasses of the farm, with the by-products of the mills and dairy. But can he afford to do this? No; not until our Chicago packers will discriminate in price and pay more for young hogs fed in this manner than for those plump corn-fed hogs.

The farmers of this state, at least those who make a business of feeding for the open market, will make more money in producing 200 to 250 young hogs, farrowed in March or April and pushed till September or October, than in any other way. For at the present prices of corn, oats and rye, combined with the above by-products of the mill and dairy, there will be a good profit in feeding hogs. The day has passed when Illinois farmers can market the raw products of their farms. The grains and grasses must be condensed into a finished product, such as pork, beef, mutton, wool and the dairy products, and how best to condense these brings us to the question of feeds and feeding. On this depends very much our success or failure, either as breeders of pure bred stock for the trade, or as feeders of swine for the market. A strictly first-class feeder must be born with the qualifications in him. If he is not, he cannot be made such and we cannot successfully feed any kind of stock, much less swine, for it is one thing to "sling" out corn to hogs and another to feed them as they should be for the purpose for which they are intended, and here comes the question of feeds.

We will now suppose that you are feeding your brood sows that have been bred for their spring litters, and want to have them bring forth good strong litters of even pigs, that are ready to hustle for their dinner one minute after they are born. If so, do not stuff your sows with corn all winter. If you do, your expectations will not be realized. You may ask, Why not? But for the information of any young breeders or beginners, I will say that the exclusive feeding of corn to brood sows produces nothing but fat. She should have feed that will grow bone, muscle, hair, etc. This needs much besides an all corn ration, for while a litter of pigs from a sow fed in this manner would of course have hair and some bone, they would have very little muscle or strength. To get the best results from your brood sows, I would use a mixture of different feeds. During the winter season use oats ground in equal parts with corn and to this add about one-half in bulk or even in weight, of wheat middlings or bran, and to keep the digestion good and everything in the best possible shape, add to this about 10 per cent. of oil meal. Feed all mixed into a thick mush about as thick as would pour nicely. If fed warm, so much the better. If I was feeding young pigs from fall litters I would cook or scald the feed for them, not that I think the cooking would add much, if any, to the quality of the feed for producing growth, but for the reason that

the pigs like it better, and will eat more of it and do not chill. Nothing looks so unthrifty to me as a lot of young pigs trying to eat slop when very cold or frozen. They eat a little, then run for the sleeping pen and pile up to get warm, and when feeding time comes again they come out of the nest humped up and steaming, ready to get chilled again; while if fed on warm feed, they will all eat their breakfast heartily and enjoy it and will take some exercise before going back to their sleeping places. If I was feeding a bunch of last spring's pigs for the Chicago market and wanted only to get them to a proper weight to ship, I would feed them all the corn they would eat and some of the other feed mentioned besides, just for variety. We have found one of the best things we have ever used in addition to the feeds mentioned during the winter months, or season when there is no grass, is a feed once every day of sugar beets, which is much relished by our hogs and pigs of all ages. After once getting a taste of them the hogs will leave almost any feed to eat sugar beets. I have said nothing about the feeding of milk to pigs, but everyone knows that nothing can equal good milk for young and growing pigs, especially if added to the feeds mentioned. What I have said so far applies to the winter feeding of brood sows and pigs. If it was during the season of young clover or other grass, I would turn the brood sows, before farrowing, on the clover and add a daily feed of corn.

If it was young pigs, I would do the same and continue the mixed feeds of thick mush, only instead of feeding it warm, would let it soak from one feed to another, but never to sour. Would also use the same feed for the sow after farrowing, commencing at farrowing time with no feed for twenty-four hours, but plenty of fresh water to drink, then using a little mixed feed, gradually increasing the amount as the pigs required more milk from their dam until the sow was getting all she could eat. Good judgment should here be used by watching the young pigs daily, noting if all are thriving. If during early spring and the weather is cold, see that the little fellows take plenty of exercise, otherwise you would find them getting very fat and plump, especially in their fore parts. The neck and shoulders looking beautiful, you might think you had in these pigs a show litter, but if allowed to remain in their nest all the time without exercise, you would soon note a quick jerky breathing, indicating a sure case of thumps, which, if well developed, can hardly be cured. But I should not wander from my subject.

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There is so much to be said on the subject of feeds and feeding that one hardly knows where to stop.

Regarding the feeder, he must be a man that would rather feed and watch the pigs eat, than to do any thing else in the world, if he wants to excel. I have been looking for just such a man for years, but have never found him, so have to do my own feeding when at home. Some feeders will go the rounds and throw in the feed, no matter whether there is a half trough full left from the last feed or not, then pass on, never waiting to see if every animal comes to his meal and eats it with a relish. The old saying is that it takes a lazy man to feed hogs. I ought to have made a good one, but I have yet much to learn regarding this matter. In conclusion let me urge you all to look well to your feeds and feeding. The best mated pair in the world cannot produce show pigs without proper feeding. How many have seen a well bred pig of almost faultless form change hands, and from lack of good feed properly given, soon look like a scrub; and again, see a very ordinary pig change owners and fall into the hands of a master feeder, who would so improve him as to astonish his breeder. There are many little matters connected with this problem, such as clean quarters, dry beds, pure drinking water, clean troughs, a little scratching or brushing, all of which go to help the general thrift of the herd. Use good, sound, sweet feed, as much of it produced on your farm as you can. Disinfect all yards and pens and troughs often, and you will make the breeding and feeding of well bred swine a success.

TRAINING OF THE CARRIAGE HORSE,

BY PROF. E. DAVENPORT, DEAN OF THE COLLEGE OF AGRICULTURE.

It is strange, indeed, that the horse is not better understood by his human master, and he who would secure the highest service from this noblest of animals must become a close student of his nature, both physical and mental.

In physical power he is vastly our superior, both in strength and agility, and that is why we have enslaved him. That is the reason, too, why he cannot be controlled by any physical methods that we are able to employ. From long association with man he has acquired mental faculties of a high order, not unlike our own. Pride, jealousy, anger, affections are as pronounced mental traits of the horse as of man. His nervous system is highly organized and exceedingly active, particularly as regards motor impulses. But while most of our mental attributes have their counterpart in the horse, and of no mean order, yet the horse lacks the fruit of the higher development, viz., coördination, balance, judgment and courage. Herein lies our superiority. Here is our advantage over him. If we are able to supply what he lacks, the moment he becomes conscious of it, from that moment he is our willing slave and he will be proud to please us. To recognize a superior intelligence and to obey it is evidence not of stupidity, but of high mentality. The allegiance of stupidity in animals, as in man, is cowardly, freakish, and not to be trusted; but the allegiance of trained intelligence is that of absolute surrender on the part of the one, and it stimulates in the superior a regard that is close indeed to friendship.

If the physical energy of the horse is not controlled it is dangerous. We cannot control it directly, but we can teach the horse to control himself and then we can discipline his gaits and his every action through the medium of his own mentality. It is not different from that in the early education of a child, except in

degree and is therefore vastly simpler. I will lay down a few principles, which, if followed, will make the training of the intelligent horse easy. They are the ones that can be trained, and they are the ones that are generally spoiled.

Let the trainer fix one thing in mind and never for a moment forget it even under emergencies of excitement. The first training must be directed to the mentality of the animal, and physical training is last of all. Therefore at the outset what the animal does is of much less consequence than what he is thinking about, and as the training proceeds and nears the finish what he is thinking about is of much less consequence than what he does. Therefore at the beginning put little restraint upon his actions, only enough to attract his attention, later insist upon instant and exact obedience. Suppose the horse has never been handled. The first object is to induce him to think about you. This he will not be at all inclined to do. He is more interested in his own affairs. Attract his attention by some experience that is new to him, that he may connect it with your presence and begin to realize that all beings are not horses like himself. Put on him a harness, or better, a bitting rig. Take him alone with yourself away from horses, that whatever happens he may attach to you; then be certain that nothing serious happens. Never be in a hurry, and do not spend every minute trying to induce him to do something. Do the acting yourself without regard to him. If in a small yard let him go loose; if in the open have attached a long line or halter, and do not be too particular about seeming to have a strong hold of him. Give him liberty, but always have a hold upon both him and the situation. Excite his curiosity, for the horse has a weakness in this direction; but never forget that his natural instinct, inherited from the wild state and not yet bred out of him, is timidity.

Bring things to him that slightly frighten him, but remove them instantly, not out of sight, but farther off. Let it be something that you can handle, as a blanket or umbrella, in order that he may see that it comes and goes independent of himself, but according to your action. Do not at first startle him with things that make a noise. He cannot locate such objects. But do not be afraid to bring to his attention at the first lesson a great variety of objects that are new to him and that seem more or less frightful, in order that he may connect your presence with their disappearance. He will not only learn to be grateful to you for relieving distress, but

will learn very soon to believe that in your presence all bad things will be controlled and that nothing is to hurt him. The more little frights he gets the better, the bolder will he become and the more will he lay to your account. Do not yet have him "go." Simply entertain him.

At each new lesson set out to teach him not many things, but one new principle enforced by as many facts as necessary. Very soon bring something to his attention always in your possession, that when thrown away from him makes a noise. Go and get it and let him see that you can manage the dreadful thing. Suppose it is an old piece of sheet iron, an old tin pail or a barrel. Kick it about, but never towards him at first. Walk over and upon it and bye and bye he will do the same.

Lay upon him and hitch to him all sorts of strange looking and horrid sounding things, one at a time, so attached that if a particular object frightens him it can be instantly removed and taken to him for examination. Later take him to objects that frighten him. In all this he will feel his inability to cope with the situation and he will form an exalted estimate of your courage and power. These are qualities you desire to stimulate in him and it can best be done by imitation.

Now take him out to see the world. Put lines on him, but leave one of them out of the turret to serve as a halter in case of necessity for he will turn and come toward you for protection at the first new sight and you must not chastise him for it. Do not try to start him, nor to guide him at first. Wait until he starts, then follow as if driving. Let him go where he pleases, if only he will go somewhere. Do not slap, whip, nor hurry him. He will start off after a while and go until he gets tired. When he stops go up to him, adjust the harness, and after he begins to sweat, more from excitement than from exercise, remove the harness and rub him off. He itches and is grateful for the relief. Sit down by the roadside. He will come to you in every case if your previous work has been good and the closer he can feed the better he will be pleased. Harness and resume the journey and with a gentle line attempt to guide his direction. He will resist. Release the line, but try again. After a few attempts he will obey the line as being easier than resisting. Meet resistance with persistence and you will always conquer. Meet it with physical power and you will always fail, or if you succeed you will spoil the best development of the animal.

The word "breaking" is the most unfortunate that could be applied to the horse. If it means anything it means a subjugation of his spirit, whereas we desire rather its encouragement and its discipline. "Breaking" at best is negative in its results. Training is the thing, for it means development through use, and when finished the horse will be in possession of all his powers, and he will have had his timidity replaced by the courage that he has borrowed from the master and which in a large measure the master must always supply by his presence.

Before he is attached to any vehicle accustom him to the most horrible sights and sounds procurable that are ever to come his way. Go with him and examine every frightful thing, or if that is not possible stand still until the fright is passed. If he will not stand, then bring him back to the spot where he took the fright and do this until he is content to remain. Do not be afraid of a colt running away. That is not a trick of a colt, but rather of a horse that has had more experience than training. Do not hesitate to put him into any kind of fancied danger, but keep far away from any real danger. The more strange objects he encounters at a time the better. Take him into a busy, noisy street. He is unable to analyze the situation or to single out any particular object of fright. If any one of these things should come to his pasture he would bolt, but being on all sides he is dazed, and he does as we do when confused—does nothing. Be always sure that you can control him easily and without his knowledge. Always have more than one way out of a predicament, and always be alert enough to see more than the horse can see, and to see it before he does.

All this will breed courage and confidence in you. Never repress nor deceive it, for it must ripen later into affection something like the faithfulness of the dog for his master.

By the time he is hitched to a cart, not a buggy, the greatest job is over, but do not for a moment relax vigilance, for he is more liable every day to bolt and run away. He has been feeling freedom of movement lately and he may forget his dependence upon you. Remind him of this from time to time by doing him a service or by helping him out of a fancied predicament, planned and executed by yourself for the purpose of teaching him a lesson.

For several days before hitching to the cart accustom him to the thing by driving him across the thills, feeding him off the seat,

backing it against him and drawing it beside him. Punch him with the thills behind and between the legs. The first time he is hitched to the cart will be the first time you will need an attendant. Do not be in a hurry. Put him in and take him out of the thills repeatedly and the first time he will stand long enough buckle the thill straps on each side at the same instant. This will be enough to draw the cart if he starts and the attendant must keep it steady behind him until he will stop. Hook the tugs at the first opportunity and go ahead. He should have been taught to stop and to start at the word, but do not try to make him stand still for it is the severest lesson to teach a horse. If he will stop instantly when told be satisfied to let him go when he wants to start.

But soon he must be taught to stand after hitching to the cart until he is told to go. After he has had a number of days' experience begin this lesson. Drive him a little before hitching to the cart, then try to get him to stand until told to go. If he will not, let him go, but bring him back, unhitch and put him in the barn. In five minutes hitch up again, and repeat this until he is confused and has no idea whether he is to go or what is to happen. Keep at this until he will not expect to go until told, then always start off on the walk. Somewhere about this stage he will begin to make plans himself. Resist this, but do not carry resistance to the breaking point. Confuse him by change of habits. Choose something that you can enforce, and after a few trials he will surrender to you the business of making plans.

Now that his training from the mental standpoint has well progressed he may be allowed to develop his gaits, always beginning everything from a walk. At an akward or rebellious move bring instantly to the walk.

Last of all, put him with his mate, now on one side, then on the other, and let the natural rivalry develop their easiest gaits, of which the long, low stride is the most useful. As you value a driver, do not put him beside an old horse. He should get his education from you and not from a horse, and he must recognize you as his disciplinarian and friend.

THE SUGAR BEET INDUSTRY FOR ILLINOIS.

BY PROF. P. G. HOLDEN.

In 1747 Margraff, a German scientist, discovered the presence of sugar in the beet and predicted that it would some day become the source of great wealth.

Fifty years passed and another German by the name of Achard, a pupil of Margraff's, had worked out a method by which he believed that sugar could be produced commercially from the beet. Through government aid he erected a factory in 1805 with a capacity of 525 tons for the season.

The Napoleonic wars had destroyed commerce, the ports of Europe were blockaded. The price of sugar ranged from 25 to 50 cents per pound. Napoleon's attention having been attracted by the loaves of white sugar made at Achard's factory, he issued a beet sugar decree, appropriating money, setting aside land, establishing sugar schools, and dispatching thither students from the universities to study the new industry. A hundred and more factories scattered over France and a few in Germany were soon operating. But in 1815 Napoleon fell and in the reorganization of nations which followed the battle of Waterloo, government aid was withdrawn, sugar again flowed in from the tropics, and with one exception the factories of both France and Germany were ruined. However, the possibilities of the industry had been shown, interest again revived, factories were rebuilt, and in 1840 the industry was again established upon a paying basis in both the countries mentioned. Since that time the production of sugar on the average has doubled with each decade until now Europe has become the greatest sugar producing section of the globe; the production now reaching the enormous sum of 10,000,000,000 pounds annually, or 5,000,000 tons, equal to 200,000 car loads of 25 tons each, or a train load 1,600 miles in length.

Germany alone supplies over one-third of this vast amount—

1,800,000 tons. This means that $120,000,000 annually are either retained at home or flow into Germany from non-sugar producing countries. In ten years this has amounted to $1,200,000,000, or an average for each of the 400 communities with factories of $3,000,000.

On the other hand, turning now to the United States, the one-half dozen or more attempts to establish factories previous to 1873, when the Alvarado, California, factory was erected, were failures. Perhaps Illinois can boast of the most illustrious of these. I refer to the experiences of the Gennert Bros. at Chatsworth and later at Freeport, between the years 1863 and 1870. This experience cost the parties $350,000. For the benefit of those who are not familiar with the history of this experiment it ought to be said that the failure was due to a combination of causes, prominent among which were the lack of knowledge of the details of the work on the part of both the manufacturers and the growers, and also the lack of water supply for the factory.

Today the beet carries a much higher per cent. of sugar than it did then, and relatively a much higher per cent. is recovered through the greatly improved factory methods now used. Instead of six, ten per cent. of sugar is now obtained.

There are now six successful factories operating in the United States—three in California, two in Nebraska, and one in Utah. At Rome, New York, there has recently been completed a small factory. Bay City, Michigan, or the vicinity, has closed a contract for a factory, and Henry Oxhard, who erected three of the existing factories in the United States, has begun the erection of the second largest factory in the world near Los Angeles, California. It will cost over $2,000,000, and will consume 2,000 tons of beets daily.

On the average the United States has imported annually during the past ten years $100,000,000 worth of sugar. To foot this bill requires one-fifth of the agricultural exports of the country, or nearly the entire export of wheat and flour. The sugar for Illinois alone costs her people over $12,000,000 annually—one-fourth to one-fifth the value of her great corn crop.

To better appreciate the magnitude of the sugar question let us bring it into still closer range. The communities of Champaign and Urbana with their combined population of 15,000 send out of their midst each year to foreign countries $50,000 which ought to go into the legitimate channels of home commerce. Galesburg with its

20,000 population exports $67,000; Rockford with its 35,000 exports $120,000. Divided equally among the 102 counties of the state each county exports $120,000 for sugar. These are sums of money which the communities can well afford to look after.

However, the question of introducing the sugar beet industry into Illinois is not a matter of sentiment. It is purely a question of business, especially when we consider seriously the advisability of investing money in a factory, or as farmers the supplying of that factory with the raw material necessary for its operation. This leads us to inquire more fully into the relations of this industry to the community, for it must necessarily be more than an individual enterprise. The willingness of a few individuals to grow beets is not sufficient; there must be an organized community interest and support based upon something more than enthusiasm, otherwise capital will not invest.

Anyone who will take the trouble to investigate the matter can hardly fail to be convinced that the industry produces a marked effect upon the community in comparatively few years, supplying more than the ordinary conditions of prosperity. The greatly improved condition of the rural classes in Germany within the past fifty years is due in no small degree to this great industry. The European countries were not slow to recognize the advantage of this industry, and when the limit of home consumption was reached, bounties were paid upon exports of sugar, so that today Germany, France, Austria, Russia and Belgium produce double the amount of sugar consumed by their people. This bounty considerably exceeds $20,000,000 annually and no doubt has been a prime factor in enabling Europe to hold the markets of this country for so many years.

The six successful factories in the United States produced, in 1896 and 1897, 40,000 tons of sugar, or an average of 6,600 tons each, worth $660,000, which was divided among the farmers and manufacturers as follows: For the 60,000 to 70,000 tons of beets necessary to produce this amount of sugar the farmers received, at $4 per ton, $240,000 to $280,000. Of the other, say $400,000, which goes to the factory, $70,000 was paid to local laborers for help in and about the factory, while $130,000 was paid for coal, lime, rock, coke, sulphur, oil, sugar sacks, etc. In case the factory is owned by local capital the profits of the factory will remain in the locality. On the part of the farmer the only money which would necessarily

be sent out of the community would be for tools, the first cost of which would not exceed $90 for each farmer, or say $36,000 for the community, and these would last on the average ten years.

These figures are for the average of six factories. The Chino factory during the last campaign paid $420,000 to the farmers for 99,000 tons of beets, and $110,000 to laborers. The Watsonville factory, owned by Claus Spreckles, paid the farmers $650,000 for 160,000 tons of beets. The product of this factory was 20,000 tons of sugar, worth $2,000,000. The Grand Island factory, established in 1890 by Henry Oxnard, is one of the smallest of American factories. It cost $350,000 and has a daily capacity of 350 tons. The past campaign opened the second week in September and closed the 31st of December, running 110 days. This factory worked up approximately 40,000 tons of beets, for which it paid the farmers $160,000, $40,000 more being paid to 160 local laborers. It used some 8,000 tons of coal and 2,000 tons of lime rock, besides large quantities of other supplies. The effects of such large amounts of money distributed annually among the farmers and laborers are felt in all channels of business in the community.

The industry has produced a marked effect upon land values and rent. Eight years ago at Grand Island and Norfolk land could be bought for from $20 to $40 per acre and rented for $2. Today the same land cannot be bought for less than $80 to $100 and rents range from $4 to $7, depending on the distance from the factory, kind of soil, etc. I was repeatedly informed that there were fewer mortgaged farms about Grand Island and Norfolk than anywhere else in the state. The opportunity was not afforded to verify this statement, but I have no doubt it is true. It certainly was apparent to the most casual observer that there was prosperity in and about these towns.

To my question, "Why are you growing beets?" which was repeatedly asked of farmers delivering at the factory, one of the three following replies was invariably given: First, "Because it is the surest crop we can raise." The beet feeds deep and is less affected by drought than most other crops, is not injured by frost which would kill corn or potatoes, and rarely suffers from insects or fungous diseases. Second, "Because it is a cash crop, the price is fixed by contract, and the market is certain." Third, and this reply was most frequently given, "Because there is more money in it than in other crops."

It ought to be said in this connection that the Nebraska farmers were suspicious of the business at first, and it was with the greatest difficulty they could be induced to grow beets for the factories. They would take no risks, and the factories found it necessary to purchase tools and rent them to the farmers, and even then they were short of beets. But the attitude of the farmers towards the business has entirely changed. As they have become more and more familiar with the details of the business the acreage has increased until there is a sharp competition for contracts with the factory to supply beets, the acreage being limited only by the amount of beets which the factory can handle. Unfortunately both the Nebraska factories were so constructed that an enlargement is practically impossible.

There is another very important thing which the industry does. It brings into or rather builds up in the community better agricultural practices. Through the most scientific methods of breeding the sugar in the beet has been increased from 6 to 16 per cent. in less than 100 years. The beet is a thoroughbred, and like highly bred animals tends to degenerate under unfavorable conditions, that is, to revert to the original or normal type. The careless methods too often practiced with corn would prove disastrous with the beet. Beet culture means a higher grade of farming, a more intensive agriculture. There seems to be an impression that the beet would drive other crops from the community, thus establishing a one-crop agriculture. If it would lessen the production of corn and oats somewhat in Illinois, perhaps we would agree that it would be a good thing, but I am compelled to say that it will not even do this. It can be easily shown that every other agricultural industry has increased with the introduction of beet culture into the community, due to the more intensive agriculture which came in with the beet. It diversifies the crops of the farm, but does not exclude or even diminish any of them.

To produce our own sugar does not mean that Illinois must become one great beet field. Far from it. Fifty factories supplied with 200,000 acres of beets, equal to nine townships of land, less than one-third of Champaign county, devoted exclusively to beet culture, would produce the $12,000,000 to $14,000,000 worth of sugar for Illinois.

Within a radius of seven miles of a factory, or hauling distance, there are 97,000 acres of land. Therefore to supply the

average factory with the necessary 4,000 acres of beets would require less than $4\frac{1}{2}$ of every 100 acres provided they were all grown within this radius. At both Grand Island and Norfolk only three-fifths of the supply are produced within this radius, the other two-fifths being produced outside this limit and shipped in by rail, a distance in some instances of 85 miles, so that in fact not more than three per cent. of the land is really given up to beet culture.

COST AND PROFIT OF GROWING BEETS AND OF THE MANUFACTURE OF SUGAR.

The relations between the grower and the manufacturer are based upon a contract, the terms of which are essentially as follows: The farmer agrees to grow a certain number of acres of beets and deliver them at the factory at such times as the manager may direct. In practice it works out as follows: Half of the beets are delivered when harvested, the remainder are pitted by the farmer and delivered at call. The farmer must purchase his seed of the factory at 15 cents per pound and sow 15 to 20 pounds per acre to insure a full stand. $4.00 per ton is paid for all the beets testing 12 per cent. sugar and 78 coefficient purity. If beets fall below the standard the price is reduced, but no beets will be accepted that are below 10.5 per cent. sugar and 73 coefficient purity. Beets delivered during the month are paid for on the 15th of the following month. These are the terms of the Grand Island and Norfolk contracts. There is no occasion here to discuss their merits and demerits; however, there are some objectionable features which should be avoided.

The following figures are given as a fair illustration of what can be expected one year with another. They are taken from Mr. Stark's ledger and are the average of his five-years experience in the business at Grand Island. The itemized statement is given, since it will be suggestive:

Plowing one acre	$ 1 50
Fitting and planting	1 00
Twenty pounds seed at 15 cents	3 00
Bunching and thinning	5 00
Four hoeings	5 00
Six horse cultivations	1 50
Lifting beets	1 25
Topping	4 00
Delivering to factory	4 00
Pitting half crop	75
Rent of land	4 00
Total cost of one acre of beets	$ 32 00
Average yield for five years, 12½ tons at $4.00 per ton	50 00
Net profit	$ 18 00

This year the Sass Brothers, near Grand Island, grew 115 acres and the yield was 10 tons per acre. They received $4,600 for the crop, paying out $1,265 for extra help, leaving $3,335 for their labor, rent, etc. Mr. Giese, who is a very successful farmer, grew 25 acres of beets this year and 40 acres of corn. His beets brought him $50.40 per acre, or $18.40 above cost of production; while his corn crop, which yielded 50 bushels, was worth in November 16c per bushel, or $8.00 per acre, or a little more than enough to pay the rent. He informed me that this 40 acres would be planted to beets next year.

The profits to the factory are comparatively large. Without going into details, it might be said that the cost of manufacturing a ton of beets into sugar is $7.00, the first cost of beets being $4.00 and the factory expenses $3.00. This takes into consideration everything, including repairs, salaries, interest on investments, etc. The value of the sugar from a ton of beets is $10.00. In other words, it costs 3½ cents to manufacture a pound of sugar, which is worth five cents. Some of the factories in the United States are doing better than this.

With the present duty of 80 per cent. ad valorem, and a countervailing duty equal to the bounty, our factories are protected against the export bounty system of European countries. Without protection the European manufacturer can place his sugar in our markets for less than it costs him to manufacture it.

It has been shown by repeated experiments that Ohio, Indiana, Wisconsin and Iowa can produce sugar beets of an excellent quality. The recent extensive experiments carried on in our own state leave no doubt as to the ability of Illinois to produce her own sugar, and no state in the Union offers better natural advantages. It has good soil and climate, plenty of coal, lime rock, and pure water, good markets, and the best of transportation facilities. What our people lack is a practical knowledge of the many details of the business, but these can be learned here as well as in California or Nebraska. There is no such thing as a few individuals going into the business in a small way. It must be run on a large scale, or not at all. Many letters have come to the Experiment Station asking if fruit evaporators or old sorghum mills could not be utilized for sugar manufacture. Such an enterprise would result disastrously. It requires the very best machinery for every step of the work, and skilled superintendents for every process. Whether the factory is

established on the coöperative plan, as in Germany, or on the non coöperative, as in America, there must be a general community interest and support. In either case, the people must contract to supply the factory with at least 4,000 acres of beets annually for at least five years.

Any community considering the advisability of establishing a factory should organize, provide itself with the best literature on the sugar beet question, appoint a committee of farmers and business men to visit some of the best factories in the United States. But this is not enough. Much more than this should be done. Each community should grow at least three five-acre patches of beets, not with hand tools, but under prevailing factory methods, using the best sugar beet tools in the market. I need only remind you that the railroad companies and implement manufacturers will do their share to encourage the enterprise.

The growing of beets should be under the direction of some person familiar with all the details of the work. This is made possible and will be comparatively inexpensive if several localities will coöperate, thus enabling one man to direct the work of eight or ten communities. This may cost the community $200, but suppose it costs $5,000 for the 200 or more farmers and business men interested in the enterprise, what does that amount to when we consider the hundreds of thousands of dollars at stake? Every dollar spent this way will save hundreds when the factory becomes a reality; and should the people find that after all they did not want a factory, how much better that it was discovered at so slight a cost. Unless the people of the community are willing to do this I would advise them to leave the sugar beet industry alone. There is a German saying that "all beginnings are hard," and this is no exception. However, I predict with confidence that at no very distant day Illinois will produce her own sugar.

FINDING A MARKET FOR OUR CORN CROP.

BY E. S. FURSMAN, EL PASO, ILL.

There was a time a few years ago when the favored farmers in central Illinois with our large corn cribs filled to overflowing relied upon a failure of crops every two or three years to make a demand for our corn. That time has passed. The knowledge of clover as a fertilizer and our new methods of cultivation have made it almost impossible to cut off the supply by extreme season in any state of the corn belt.

Few men can grasp the idea of this vast supply of corn. When we realize that we produce annually two thousand millions of bushels, is it any wonder that this problem of demand is hard to solve? If we would haul our corn crop to market with fifty bushels as an average load, can we realize that the crop of one year would make a string of wagons, thirty feet for each wagon and team with fifty bushels as a load, which would reach four times around the world?

There was never a greater opportunity for us to reach out for the markets of the world than is offered by the Paris exposition in

1900. We can reach from forty to fifty millions of people, a large per cent. of whom know nothing of the value of Indian corn as a human food. We produce in the United States ninety-three per cent. of the corn used in the world, yet only thirty-one per cent. of the population of the world know anything of corn as an article of food.

At the last exposition in France an effort was made to introduce our corn into some of the European countries and with some little success, as our export trade is increasing every year. But it is too slow. Instead of exporting thirteen or fourteen millions of bushels per month we can spare from our annual production 550 millions. It is our first duty to make a home demand. Only a few corn growers know anything of the vast number of purposes corn is used for. It makes our beef, our pork and lard, our poultry and eggs, our mutton and wool, our bread and our puddings. I have today put up in glass jars fifty-two different articles, the commercial products of our common field corn.

My plans for a grand special exhibit of corn at Paris is to get the State Boards of Agriculture in Ohio, Indiana, Illinois, Iowa, Nebraska, Missouri and Kansas to unite in asking the Secretary of Agriculture to prepare plans, and to commence at once to arrange for this exhibit. I have been at work for the past three months studying a design, a picture that would attract the eyes of the foreigners who visit the fair. This is a picture 60x40 feet, made entirely out of corn, and is so striking and attractive that it will excite the curiosity of the foreign people long enough to convert them to the use of corn products. The picture is shown at the beginning of this article. It shows the American flag covering both hemispheres, supported by the American eagle and crowned with King Corn, bearing the Latin legend, "In this emblem is our hope." At one side is the portrait of Washington to typify the United States, on the other Lafayette's, to typify our hereditary friends and of the continental markets we seek. In the middle of the field, surrounded by a corn field, is a great cannon firing corn over into the old world.

We ought to have in connection with the exhibit an American kitchen, where all kinds of food that can be made out of corn would be served in the best of shape. Mush and milk could be given away by pretty American farmer girls; white corn bread and bacon could be sold by some motherly farmer's wife.

If this work is done by our State Boards of Agriculture, and the

exhibit put under way, it will stimulate hope in the hearts of our corn growers for the future, and result in a great benefit to our people.

CARE OF MILK ON THE FARM.

BY E. H. FARRINGTON,
PROFESSOR OF DAIRY HUSBANDRY, UNIVERSITY OF WISCONSIN.

The necessary and rational care of milk, to insure its purity and wholesomeness for consumption, has been recorded in books and papers for many years. Persons who read, can easily obtain elementary and advanced instruction on the subject by following the directions and advice that is given every year in nearly all the agricultural and daily papers. The literature on the subject is clearly available and within the reach of all milk producers, but the eagerness to seek and find it is often lacking, as well as the disposition to observe instructions and put them into daily practice.

Since we must accept the situation as it exists in many communities where the milk producers are not book worms, the seekers after pure milk should seriously consider what they are going to do about it; what will be the most successful way of teaching the proper care of milk to those who need such instruction.

Very few heathen are converted by simply sending them the glad tidings that they must be good. The successful missionary probably has to go into elementary details and instructions in regard to what ought to be done in each case to accomplish the desired end. Milk producers are often benefited by something more than an imperative statement that the customer wants fresh, sweet milk.

The practice of successful advertisers of keeping the subject or substance in which they are interested constantly before the people is a course that may be wise to adopt in an attempt to procure pure milk. Constant repetition of instructions often makes such an impression on one's mind that it may become more or less automatic in obeying them, and the application of this practice, with some reasonable rules for the care of milk, will undoubtedly tend to improve its purity.

A survey of the situation shows that the cow is not the only responsible party in the question of wholesome milk. The part she

takes is generally fulfilled when an examination shows that she is in sound health, and the milk is not used until at least one week after calving. Some authorities claim that a cow should go unmilked from one to two months at the end of her period of lactation, and that the milk of "a stripper" is ordinarily so changed in composition that it undoubtedly is less wholesome and more indigestible than at any other time during her milking period.

The feed of a cow usually has very little influence on the purity of her milk except in stable feeding, when musty hay, mouldy grain or decayed ensilage are placed before her. It is nearly impossible to prevent the contamination of milk if cows have access to these unwholesome foods. The dust and bad smells from them get into the milk pail and are absorbed by the milk after it is drawn from the cow, so that the pollution of the milk from this source is almost entirely mechanical and gets into the milk after it has left the cow, rather than physiological and due to the inability of the cow's digestion to assimilate musty feed and transfer the mouldiness and decay to the milk in her udder.

The manufacturing of milk from feed by the cow machinery is not thoroughly understood by the best authorities. It has recently been proved that she can convert absoutely fat free food into milk which contains the normal amount of fat, and she may have the power to transform unwholesome food into pure milk, but the danger from her being surrounded with musty feed and its dropping into the milk is so great that it is unsafe for cow owners in general to try the experiment.

The ends of the cow's teats are moist; dust from her bedding, or that kicked up by her travels during the day will stick to this dampness. These conditions are so favorable for the growth of bacteria that the milk in the ends of the teats is impure, and may be even soured between milkings. This "fore" milk is nearly always so full of ferments that the first milk drawn from each teat should be thrown away and none of it saved until the passage is thoroughly rinsed.

After the cow has been cleaned by brushing all the dirt, dust and loose hair from her flanks and udder, she should be *always milked with dry hands*. The warm milk ought to be strained, aerated and cooled at once, not in the ordinary stable, but in some clean place, where it is protected from dust and bad odors.

A strainer may be made of cotton flannel, or at least four

thicknesses of cheese cloth.. A fine wire sieve does not strain milk sufficiently.

Proper washing of the strainer cloth is very important. It needs the same kind of washing that should be given to all the milk tinware. First rinse in cold water until free from milk and dirt, then wash thoroughly with warm water and finally *scald with boiling hot water.* After scalding the tinware and strainer cloth they should be hung out to dry, in the sun if possible.

The aeration of warm milk is accomplished by many different devices now on the market and nearly all of them are efficient. Dipping the milk, by lifting it a few feet above the can and pouring it through clean air is a great aid to its keeping qualities, and this should be done at frequent intervals for half an hour after milking, while the milk is cooling. Pouring the warm milk from the strainer over or through an aerator is better than dipping, and the improved purity of the milk is worth many times the cost of an aerator.

The thoroughly aired milk should be cooled as soon as possible to a temperature of 40 to 50° Fahr. This is generally accomplished most economically by setting the cans of milk in clean, cold water. These cans must not be tightly covered.

Never pour warm milk into cold milk, but cool each lot separately. If milk is protected from dust and kept at a temperature of 50° Fahr. in clean, scalded tinware, after the few suggestions already mentioned have been faithfully followed, there will be no difficulty in keeping it sweet and pure for several days.

COWS IN DRY WEATHER AND FLY TIME.

In a certain town there are two farms, one on the north side of the road and the other on the south. Both farms have daily supplied a creamery with the milk from 12 cows during the past three years.

Now the pastures on each farm, in July and August, attain about the same degree of barrenness; the sun shines with equal intensity on both lots, the rain fails to beat upon either of the pastures or on the cows, and the latter are grieviouly tormented with flies. While both herds are exposed to the same unpleasant conditions during the day, there is one important difference in their treatment after they are gathered into the barns at night.

Those on the north side of the road enter a gate on the west and go thence across a dry barn yard to the neatly whitewashed stable; there they find green feed and grain set before them. In

August this feed consisted of green corn and 35 cents' worth of corn meal per day. In return for this feed these cows gave, August 1, 1897, 234 lbs. of milk, which tested 4.5 per cent. fat, making a total of $10\frac{1}{2}$ pounds of butter fat. This was worth at that time 14 cents per pound and amounts to $1.47.

When the cows on the south side farm return at night they are given no green feed or grain; the mud from the pond hole in which they have been standing all day is only partially cleaned from their udders and flanks at milking time, and the dirty switching tail of the cow makes a cloud of dust, a portion of which is sure to get into the milk.

The lack of whitewash in this cow stable, together with the pond hole and other failures to comply with printed regulations supplied both farms, makes at this creamery a difference of 4 cents per 100 pounds between the grade of milk supplied by this south side farm and that from the north side of the road. But if the same price, of 14 cents per pound of butter fat, is paid both lots of cows for their milk their reward is not the same per cow as that received from the north side cows. On this particular day these 12 south side cows gave 171 pounds of milk, which tested 4.3 per cent. fat, making a total of 7.4 pounds of butter fat, and this at 14 cents per pound amounts to $1.03. The south side cows were not fed anything when brought to the barn, but milked and left by the barnside to wander or to wonder why their milk had fallen off 42 pounds in a week and their neighbors only 24 pounds.

Now the 12 cows on the north farm were given green feed and grain each day and their milk amounts to enough to pay their owner $1.47, which is 44 cents more per day than the other man received from the same number of cows kept on dry pasture only, in dry weather and fly time.

HOW AN AGRICULTURAL PAPER IS MADE.

BY C. A. SHAMEL, MANAGING EDITOR ORANGE JUDD FARMER.

A young man begins work on an agricultural paper with no very definite idea as to the scope of such a journal and the possibilities of doing good or evil. From the beginning he is deeply interested, and as the years go by the fascination increases. True, some of his ideals are completely shattered, many of his mind creations have to be made over to fit actual conditions, but as a compensation he finds opportunities of which he had never dreamed, and the possibilities of development that are surprising. This is because the province of the modern agricultural journal is a broad one. In general the dissemination of agricultural information, both theory and practice, is its special duty. It should be so constructed that from it the well-informed reader can get all possible information as to the discovery of new facts bearing upon agriculture made by the actual tillers of the soil and trained investigators. In other words, it should be the recorder and explainer of current agricultural science and practice. For the beginner it must be a farm manual or guide giving detailed and comprehensive directions for the growing of crops, breeding and raising of stock, manufacture of dairy products, disposition of what is raised on the farm, and the like. For the isolated reader who can afford only one or two papers it must fill all the wants enumerated above, and in addition enlighten him briefly as to the weekly happenings in the world about him—the special province of the daily paper, which circumstances deny him the privilege of reading. Then a considerable portion must be devoted to the home and home making for the information of the women of the family, while the boys and girls must not be forgotten.

If all these features are to be fully developed the task of making an agricultural paper is not a small one, indeed it is quite complex and but little understood outside of the fraternity. It is for

this reason that I shall attempt to outline briefly, and of necessity imperfectly, how an agricultural paper is made. I shall write particularly from an editor's point of view, as my six-years work has been in the editorial room.

The workers on an agricultural paper are divided into three distinct departments, editorial, advertising and subscription, the two latter comprising the strictly business features. Each department has a head or chief who is responsible for the conduct of business which naturally falls to his department. The supreme authority is of course the owner, who in many cases is the editor and who outlines the general policy of the paper. To him all matters of importance are referred, in case there is any doubt as to their final disposition.

The head of the advertising department has one or more assistants, stenographers, etc., and it is their duty to solicit and look after all advertisements, see that they get into the proper issue and are in correct position. The subscription chief has a large force under him, amounting to 60 or 80 during the busy season. The entire time of this department is occupied in receiving and recording subscriptions, keeping books, looking up delinquent subscribers, employing and directing agents in field, etc. The work of each department is quite distinct, although of course the heads confer whenever necessary. Each week when the paper is "made up" the advertising man and the editor have between them to apportion the space to accommodate the advertisements and the literary matter.

But I promised to confine myself to the editorial department. The editor-in-chief is, of course, the first in authority. He writes the editorials or has them written, keeps in close touch with the chief events of the week, agricultural and general, plans the general make-up of each issue and is in the end responsible for the contents of the paper and its good or bad appearance.

Next in authority and importance is the managing editor, who is general assistant to the editor-in-chief, it being his duty to take charge of all details and see that the wishes of the chief are observed. He writes editorials occasionally, passes upon manuscript sent in for publication, sees that the manuscript is ready for the type setter on time and that the paper goes to press without delay no matter what difficulties may be encountered, does the greater part of the editorial correspondence, makes arrangements with contributors, directs the work of preparing manuscript for the printer, interviews visitors, attends as many agricultural fairs, meetings, etc., as

possible. He has from one to four assistants, depending upon the size of the paper.

Besides the editor-in-chief and managing editor, there is the commercial editor, who looks after the markets and all matters bearing on the distribution and sale of farm products; the literary and household editor, who prepares the literary features, the matter relating to the kitchen and home generally, and the news editor, who keeps track of the general news as well as that strictly agricultural. These with their assistants, stenographers, office boys, etc., make up the office editorial force, which on a large agricultural paper often numbers 25 to 30 men and women. The household editor and assistants are usually women.

In addition to the office editors, an agricultural paper that is of any real value has what we call department editors in the country. These are practical men and authorities in their specialties. For example, a first-class dairyman is paid a stated salary and is expected to furnish a certain amount of manuscript each week, look over and correct matter sent him from the head office, answer all questions relating to dairying that may be sent to the paper and keep in touch with the latest and best dairy methods. A sheep editor is selected from among successful sheep raisers, and in like manner a horse editor, a swine editor, a general farm editor, a poultry editor, a bee editor, etc., who looks after his specialty as does the dairy editor. Then a regular correspondent is secured from each important county, who is expected to keep the editor informed as to the condition of crops, and all agricultural news which is of general interest. You see the editorial staff of a large agricultural paper is a big one and if it is composed of capable men and women, much ought to be accomplished.

There is considerable misunderstanding among general readers as to the source from which matter is obtained for filling the columns. A subscriber from Missouri called at my office and said he liked our paper very much, but as all the articles were written in the office, he did not consider it very valuable. I took down my record books and showed him my list of contributors and a great mass of manuscript I happened to have on hand. He was astonished. Articles are supplied by all classes and conditions of men and women, but the paper is most valuable that gets its information from the actual farmers, fruit growers, stockmen, home keepers, rather than from those who have a well developed theory,

which has not been put to the test. I would rather have the actual experience of some successful farmer written on poor paper, in a cramped hand, with misspelled words and disjointed sentences, than an elegantly composed essay by a gentleman farmer or some learned professor who never grew a crop of corn, milked a cow or raised an apple. The successful editor carefully reads each bit of information sent in, and the writer may rest assured that his letter is appreciated and if it does not appear in full or in part, that it goes to make up the general summaries, influences editorials and is given as much consideration as any other fact of equal importance. Considerable matter of course is prepared in the office. Articles of a scientific character are usually secured from the agricultural college and experiment station men. A few of these are necessary so that the reader may keep in touch with the latest discoveries of science, but the bulk of the matter must be from practical workers. The head editors must have such a practical and scientific knowledge of agricultural subjects that they may keep errors out of their columns and be able to write articles themselves if necessary.

The matter which fills each week's issue must be seasonable, i. e., it should appear when it would do the most good. An article on cutting hay should be printed three or four weeks before harvest begins, so that the instructions contained therein can be utilized. It would be manifestly unwise to print an article on the value of heating water for cows, in August, or on planting corn, in September. Then a variety of subjects properly distributed must be used. The dairyman must have a page, the beekeeper a couple of columns, the general farmer a page or two and so on through the whole list. It is no small task to look after these features properly.

When manuscript comes in it is passed upon by the editor or managing editor, and, if accepted, is turned over to some assistant, who gets it ready for the printer. In some cases the article has to be rewritten, condensed and corrected. It is then set up and read by a proof reader. The corrections are made and the second proof, as it is called, is read. It is then made up into a page, which is again read. In spite of this careful inspection mistakes will frequently occur. After the page is made up it is electrotyped, the plate curved, put on a large circular press, a roll of paper attached and the completed journal comes out at the rate of 140 a minute.

Now, I think you have some idea at least of how the material is collected and made ready for the printer. I would like to tell how

every farmer may be of great help to the agricultural editor and to each of his readers. Send him a description of any successful farm or home practice. No matter how poorly the story is told it will be taken care of. Give the facts, send rude sketches of labor saving devices, sleds, carts, anything that will lighten farm work in or out of doors, which have been successfully used in the community. These, with the descriptions, which should always accompany them, are more valuable than long articles and are harder to get. Keep the editor informed as to the condition of growing crops, appearance of animal or plant diseases and the seriousness of the infection, work and meetings of local agricultural associations of any kind, in fact, all agricultural matters of general interest. If he will do this it will take but little of his time and will result in a paper which will not be dry and unprofitable, but will each week contain something that can be applied by many farmers similarly located in every county. He is thus not only helping the editor, but his brother farmer, and only in this way can a paper be made truly valuable.

Where do agricultural editors come from and what training is necessary? This calls to mind a description by Will Carleton of what many people considered adequate editorial timber. An old gentleman takes his smallest, most worthless boy to the editor of his favorite paper and the following conversation occurs:

"Good mornin', sir, Mr. Editor; how is your body today?
I'm glad you're to home, for you fellers is al'ays runnin' away [aside.]
But layin' aside pleasure for business, I've brought you my little boy, Jim;
And I thought I would see if you couldn't make an editor outen o' him.
He aint no great shakes for labor, though I've labored with him a good deal,
And give him some strappin' good arguments; I know he couldn't help but to feel;

But he don't take to nothin' but victuals, and he'll never be much, I'm afraid,
So I thought it would be a good notion to larn him the editor's trade.
His body is too small for a farmer, his judgment rather too slim,

But I thought we perhaps could be makin' an editor outen o' him.
It aint much to get up a paper, it wouldn't take him long for to learn;
He could feed the machine I'm thinkin', with a good strappin' fellow to turn.
I used for to wonder at readin', and where it was got up, and how;
But 'tis most of it made by machinery—I can see it all plain enough now.
And poetry, too, is constructed by machines of different designs;
Each one with a gauge and a chopper, to see to the length of the lines;
And since the whole trade has growed easy, 'twould be easy enough I've a whim,
If you was agreed, to be makin' an editor outen o' Jim."

The editor sat in his sanctum and looked the old man in the eye,
Then glanced at the grinning young hopeful, and mournfully made his reply:
"Is your son a small unbound edition of Moses and Solomon both?
Can he compass his spirit with meekness, and strangle a natural oath?
Can he leave all his wrongs to the future, and carry his heart in his cheek?
Can he do an hour's work in a minute, and live on a sixpence a week?
Can he courteously talk to an equal, and browbeat an impudent dunce?
Can he keep things in apple-pie order, and do a half dozen things at once?

"Can he press all the springs of knowledge with quick and reliable touch,
And be sure he knows how much to know, and knows how to not know too much?
Does he know how to spur up his virtue, and put a check rein on his pride?
Can he carry a gentleman's manners within a rhinoceros' hide?
Can he know all, and do all, and be all with cheerfulness, courage and vim?
If so, we perhaps can be makin' an editor outen o' him."

The old man stood curiously listening, while wonder his visage o'erspread,
And he said: "Jim, I guess we'll be goin'; he's probably out of his head."

But whatever the common idea may be, the agricultural editor should have a practical and scientific agricultural education. A bright boy born and raised on a farm, remaining there until 17 or 18 years old, working hard and keeping his eyes and ears open, is a first-class beginning. If at this age he will enter a good agricultural college, taking the full course, giving some attention to literary studies, he will be several steps farther along. He should then return to the farm and for two or three years test by practice the theories he has been taught in college. If he has worked hard and been faithful in all things, he is ready to enter an editorial office as third or fourth assistant and well equipped to begin climbing the ladder of fame. He must there continue his studies, travel as much as possible so as to become familiar with agriculture in all its phases and keep in touch with the latest developments. He must be able to write good English and at all times keep his editorial columns free from errors. Any approach to slang or vulgar expression must be studiously avoided. The editor who seeks popularity by using the language of the rabble, deserves contempt and the reader has a right to be indignant, for he is thus classed with those who enjoy that which is unclean. I confess, with regret, that many of our editorial columns are disgraced with just such matter. Hence, the opportunity for a young man with high ideals and the courage to adhere to them. Then, too, he must have a high regard for the truth and not yield to the temptation to tell a little more than the facts warrant. The young man who expects to be a good editor must have steady habits, a good constitution and a cool head, for if he gets to be the chief or the chief's assistant, a tendency to lose self-control will prove disastrous. He must not be afraid of work—hard work. Not all agricultural editors possess all of these qualifications, and there is plenty of room for the right kind of young men in the field, which is a most fascinating one.

The experiences of an editor are varied. Many are pleasant some are sad, some are ludicrous. He meets many people and has many friends; and what is the sum of human happiness here, but the thought that we have friends that are tried and true? If I should leave newspaper work tomorrow, I should consider my six

years well spent, even if I retain nothing but the friends I have made. Then one must be constantly on the alert for new things and thus has many opportunities for self-improvement.

The editor will have an occasional enemy, some one who imagines he has been slighted. The other day a Minnesota subscriber devoted eight pages of note paper to telling what he thought of me in language more forcible than elegant. But many and cordial are the letters received and an occasional one smelling of brimstone renders the others more enjoyable.

An editor is asked for information on all sorts of subjects under the sun, from raising chickens to advice in matrimonial affairs. The little boy wants to know how to make a boat and to raise rabbits, the little girl to dress dolls, the school girl a subject for a composition, the school boy how to write a graduation essay, the poultry raiser how to keep eggs all winter so that they will be as good as fresh ones in spring, the young farmer how to tame a vicious colt or to persuade a hog that it is best for him to refrain from rooting up the pasture, and so on through the whole list. All are given attention and answered in the best manner possible, so you can readily see that an editorial office is no place for drones or dullards.

THREE IMPORTANT SCALE INSECTS OF ILLINOIS ORCHARDS.

BY ERNEST B. FORBES.

No recent event in the field of economic entomology compares in interest and importance with the discovery of the insidious and unsuspected spread throughout a large part of the United States of the most destructive of the fruit insects, the San José* scale.

First noticed in California about 1870, and conveyed thence in 1886 and 1887 to two large New Jersey nurseries having extensive trade outside of the state, it was not detected there until 1894, by which time it had been unwittingly shipped far and wide on infested stock and had in many cases been scattered, through the nursery trade, from new centers of dispersal. Its small size and inconspicuous appearance and the fact that the visible scale bears no resemblance whatever to an ordinary insect have made it unusually difficult to detect or understand, and it has time and again wrought havoc year after year in a large and valuable orchard without raising a suspicion of its true character.

First recognized in Illinois in September, 1896, it has now been found in twenty-three localities scattered through seventeen counties of the state. Fortunately its natural spread is very slow, and it can only be conveyed to a considerable distance, so far as known, through the agency of man. Left to itself, it infests thoroughly the tree on which it makes its appearance, and thence goes to adjacent trees as the very minute young are able to make their way during the few hours after birth in which they have the power of locomotion. Occasionally birds have assisted in its conveyance to a distance, especially when they have nested in the vicinity of an infested orchard. In most cases of its occurrence in this state it is still limited to the premises of a single owner, on which it may yet

*Pronounced *San Ho-zah.*

be exterminated by energetic and thorough insecticide measures. This fact makes it especially desirable that all should be warned against the possibility of its appearance and informed fully as to its character and appearance.

The systematic inspection of a large number of orchards and nurseries in Illinois since the discovery here of the San José scale has further called special attention to two other scale insects: The scurfy scale—the commonest of the orchard scales—and the oyster-shell scale. These, while apparently incapable of such sweeping devastation as is caused by the San José scale, are nevertheless very injurious, on the whole, to the orchards of this state. The loss to fruit growers in Illinois at the present time due to these two scales, is certainly far in excess of that caused by the San José species itself. This loss, however, is not so noticeable because of the more general distribution of these species and because the damage done to the tree attacked is not usually fatal. The scurfy scale especially is so widely spread and of such general occurrence that except in extreme cases it causes but very little comment among fruit growers, although it is without a doubt a cause of continuous, widespread, and appreciable damage. As a consequence of the general search for the San José scale made by orchardists during the past year, an unusually large number of inquiries have been received by the State Entomologist regarding these two scales, especially the more abundant scurfy scale. The oyster-shell scale has come to us most generally from the southern part of the state, where it is now doing considerable harm.

The female scales of the San José species are very small when full grown, flat, and nearly circular in outline. The central part is slightly raised and crater-shaped, that is, with a minute nipple-like projection in the middle, surrounded by a raised ring. The young scale is "dark gray, or, if rubbed, black; toward the center more or less distinctly black with a more or less distinct central white dot and surrounding ring." In the old scale the color becomes light yellowish-gray, the central part being yellow. The male scales are comparatively rare and are of so little consequence numerically as to make a description of this form superfluous. This scale is easily confounded with certain near relatives which are of little economic importance, but from which it is impracticable for any one but an entomologist or other skilled observer to separate it. In case scale insects are found which agree with the above description, they

should be sent at once to the State Entomologist for positive identification, since it is of the utmost importance to all orchardists and nurserymen that this pest be promptly recognized wherever it occurs and be dealt with at once in as vigorous and effective ways as possible.

The oyster-shell scale is of a very peculiar and characteristic form. The mature scale is shaped very much like an oyster-shell, being elongate, curved, and tapering. This scale in cross-section is seen to be strongly arched. The color is dark grayish-brown; the length about one sixth of an inch. There is a fairly well-marked tendency in this scale to lie lengthwise of the twig with the smaller end uppermost. The male scale is of a smaller size and different shape, occurs mostly on the leaves, both upper and under sides, but is rarely seen.

The scurfy scale is of a very different shape, being flat, broad and ovoid, with one end indistinctly pointed. It is grayish-white, varying with age from nearly snow-white to a dull gray, and about a tenth of an inch in length.

In dealing with an insect of economic importance, the first step taken by an entomologist is to determine its life history in order that he may be able to combat it in its weakest, least-protected stage; in fact, all insecticide methods are entirely dependent upon our knowledge of the structure, habits, and metamorphoses of the insects treated. The life histories of the three insects here considered are in general rather similar, but some differences in detail render the methods which can be effectively used against one species quite useless if applied to another. These facts have led to a very careful study of the life histories of these scales.

The San José species, like all armored scale insects, passes nearly the whole of its life cycle under the protection of a tough, waxy covering—the scale. The females hidden under these scales never possess wings, and live as free and active insects for only a few hours after birth, for they are born alive and not hatched from eggs, and during this active larval period occurs the spread of the pest from one situation to another. The male is winged, and is thus able to move about with freedom in search of mates during his short life as a winged insect. On account of the apparent connection between the presence in infested orchards of birds' nests and the scale insects it is supposed that birds are largely responsible for the transfer of the young from one tree to another, though the wind and other

insects may also be of assistance. Birds may transport them upon their feet or on portions of fruit or even on twigs used for nest building, though few nests are built after the scales become active. The whole future of an individual scale depends upon its finding, during the brief period of locomotor activity, a favorable situation for attachment. When such a place has been found, the insect inserts its long sucking beak into the tender bark and remains fixed to that spot during the remainder of its life. The spread of the insect is therefore rather slow, and this is indeed the only reason that it has not long since taken general possession of the orchards of the United States.

In the fall, at the time when cold weather puts a stop to the activity of the insect, both sexes may be found beneath the scales in a half-grown condition. The males mature in the spring, usually about the middle of May. By the end of that month the females have become sexually mature and are bringing forth living young. The pale-orange larvæ become fixed in from six to thirty-six hours. How long a larval scale might retain its power of locomotion, and how far it might travel in case it hatched in a situation unfavorable for further growth, is a point of interest still to be determined. Immediately on becoming fixed the insect begins to secrete its protective scale, and in about forty days is mature and capable of producing young. The broods become mixed during the summer, and during the latter part of the season all stages may be found upon a tree at one time. This mixture of broods makes the insect a more difficult one to deal with than the scurfy scale and oyster-shell scale, both of which begin to hatch in this latitude early in May. It now seems probable that a second brood of the scurfy scale appears throughout the state early in July, and that a second brood of the oyster-shell scale occurs early in August, at least in Southern Illinois, but no reliable scientific data are at hand in support of these statements. In the case of the last two scales, then, in addition to the winter spraying, we may apply insecticides effectively at two periods during the summer when the scales are in the egg stage.

The most desirable time to apply insecticides to scale insects in general is in the winter, when, because of the absence of fruit and foliage, we are able to use much more caustic and effective washes than at other times of the year. If for any reason the spraying for scurfy scale and oyster-shell scale is impracticable during the winter time, the infested trees should be sprayed at the time of

hatching of either brood; but, of course, preferably when the May brood hatches. This spraying may be done with kerosene emulsion or soap-suds or a mixture of the two in the proportion of one part kerosene emulsion to ten parts of two per cent. soap solution. The best spraying fluid for winter work against scales is whale-oil soap dissolved in boiling water in the proportion of two pounds of soap to a gallon of water. This must be used while hot. Where possible it is best to spray once late in the fall and again just before the buds open in the spring, but one thorough spraying is very destructive to scales if the weather conditions are favorable.

Spraying with pure kerosene during the summer has been tried with varying success, and under favorable weather conditions, with the observance of great caution, it may be permissible. It is, however, a dangerous remedy, and no one should make an extensive application of pure kerosene to his orchard till he has experimented on a small scale with sufficient thoroughness to determine positively that the conditions present and his own understanding of the method will warrant its application on a larger scale.

These three scale insects are of course preyed upon by a number of parasites, and the idea has gained some prevalence among orchardists that these friendly insects are capable of keeping them in check so that efforts on their own part toward the destruction of the pests are superfluous. This, however, is an erroneous and pernicious notion. It is thoroughly worth the while of any owner of a good orchard to keep it free from these scales; and in case the orchard is not a good one and is not worth careful treatment by its owner, there should be laws in the interests of his more thrifty neighbors compelling him to clean up or burn up his trees.

Since the discovery of the San José scale in Illinois in 1896, a thorough examination has been made of all orchards into which nursery stock had been shipped from infested nurseries in other states, and of all other orchards suspected of infestation by this scale. Under the direction of the State Entomologist all orchards found infested, with the exception of those at Sparta, Illinois, have been sprayed with whale-oil soap, the owners paying the cost of the soap and furnishing the labor necessary to do the work. At Sparta, the worst by far of any of the infested districts, no spraying has as yet been done, and it will only be when the legislature has made further and more liberal provision for such work that we can hope, at public expense, to get the scale well under control in

this very badly infested region. A fungus parasite of scale insects which has been experimented with in Florida is to be generally distributed in the Sparta district in the hope that it may be of service in killing out the scale, or, at least, in keeping it in check till appropriations are made for more vigorous and extensive insecticide measures.

WHY I CAME TO THE U. OF I. TO TAKE THE AGRICULTURAL COURSE.

BY E. T. ROBBINS, CLASS OF 1900.

The question as to what my future should be has been with me, as with most farmers' sons, the subject of a great deal of perplexing study. The fact that so many farmers' sons go to the city has led me to question whether or not the chance for success is really better there. Will careful, thoughtful work be better repaid in city occupation than in farming? Does not the farm give opportunity for the use of the best education? Such questions as these have crowded themselves upon me, demanding answers; and as a result, I have been led to study into the possibilities which the farm offers.

Most business enterprises are now carried on in accordance with the best management possible, in the light of the latest scientific knowledge. Indeed many methods of procedure are simply the result of modern educational advancement. In these professions nothing but the shrewdest management and the prompt application of the very latest information will bring even a moderate degree of success. Competition is so keen, and calculations so close, that success is not lavished on those whose efforts do not merit it.

In farming the case was formerly quite different, though now it is very similar. It has been true in every new country that the man who had land and put forth enough physical exertion in cultivating it to give his crops any kind of chance, could depend with a reasonable degree of certainty on receiving a crop. He was simply the recipient of the blessings of nature by virtue of the fact that he had land. It was not so much the farmer's effort that gave him a crop, as it was that the virgin soil had in it such fertility, such possibilities of production, that it almost forced a crop upon him. Except in newly settled regions, such conditions are rapidly passing away, and farmers are awakening, though all too slowly, to the fact

that success in farming will in the future depend on the quality of the attention the farmer gives his work. The worn-out farms in many of the eastern states, and the greatly impoverished land even in our own state of Illinois, testify that our careless, wasteful method—or rather lack of method—in farming must be stopped or our land will soon be worthless.

Not only does the condition of the soil demand that farmers put forth intelligent effort, but, on account of the close interdependence of all kinds of business, the same competition that is making a training school out of other lines of work, is forcing farmers either to fall in line and keep up by thoughtful application, or to be the victims of perpetual "hard times."

It is the man who puts thought into his work, and follows the latest teachings of science, who has crops to reap when other men have none, and who makes money when his careless neighbors are howling about "hard times." This must always be the case, for so long as there are people to be fed, as long as the human race exists, agriculture must necessarily be the most important industry; and it follows with equal certainty, that the price paid for agricultural products must be above the lowest cost of production. The farmer, then who produces the most at the least cost may rely on finding a profitable market for his crops, but the farmer who can do this is the one who is educated in the latest scientific knowledge of the conditions he seeks to influence in his work.

The failure to realize these facts has caused farmers to go on thoughtlessly following the old plans of their ancestors, looking at their work as no real part of their lives, but simply a mechanical formula that must be carried out in order to subsist. On the other hand, the careful, intelligent thought that farmers should give their work brings them to find a real pleasure in it, and an interest in the working of Nature which transforms the work of the farm from a dead weight into a means of culture and uplifting. When farmers look on their own work and enterprises as distasteful and uninteresting, can it be wondered that they stimulate in their sons no desire to be farmers? Their boys are led to take no interest in farm operations, but look upon their work as a drudgery, a kind of penalty for existence. For their enjoyment and mental occupation, in fact for their real life, they look for something away from the farm and home. As a result the boys leave the farm at the earliest opportunity and go to the city, led on to such a course by the fact that

they hear only of the brightest side of city life, and the achievements of a favored few, while they do not hear of the thousands who have found their places in the poorest classes.

Fortunately for me, one of the best methods of interesting a boy in the business of the farm was practiced in my own case. From a very small boy I always had something I could call my own. At first a small spot in the garden in which I could raise anything I pleased; later I had a pig to raise, and then a calf and finally I was given some sheep and a horse. No one who has never passed through the experience knows what a keen interest a boy takes in anything he can call his own. I used to watch and study the animals that were mine until I knew them perfectly. The care of them gave me at the same time pleasure and instruction, and the satisfaction of being able to call them my own was a source of encouragement at times when I might otherwise have been disgusted with the hard work I had to do. The interest I felt in my own property naturally extended to everything on the farm, and I began to study into all the subjects connected with it. This led me to see something of the scope of the work and the compensation that it offers for intelligent effort.

It is true that the farm does not offer the same opportunity for the sudden, often dishonest, accumulation of riches that the city does; neither does it, on the other hand, offer such a chance for complete business ruin and bankruptcy. But money is not the only object in life, and the man who works for it alone misses the real pleasure and profit in existence, and does not get the same mind and soul development that is acquired by him who gives his thoughts a wider range. The farmer surely has the surroundings which offer the widest field for study and thought, on the subjects presented to him by his work; and with the present news and literature, there is no reason why the farmer cannot keep well informed on what is going on in the world around him.

From a consideration of these things, my study of farm and city life, and the opportunities they offer, has resulted in the decision that I shall be a farmer and put into my work the best education that I can secure. In order to get the education best suited to my needs, I have come to this University to take the Agricultural Course. Aside from the fact that this is one of the leading Universities in the United States, it is preëminently the best one for me. Since agricultural methods necessarily differ largely in localities

with different soils and climate, the University of one's own state is the best to attend for an agrtcultural education.

This course, it seems to me, is such that it will put me on the best footing for progressive, successful life as a farmer. It will give me the technical instruction necessary to guide me intelligently in my work, and at the same time it will lay the foundation for advancement in all lines of mental and social culture.

THE PREPARATION OF FOOD IN OUR COUNTRY HOMES.

BY MISS JUNIATA L. SHEPPERD, INSTRUCTOR IN DOMESTIC ECONOMY, UNIVERSITY OF WISCONSIN.

My subject takes for granted that each woman on a farm has a good, well-tilled garden containing all the fruits and vegetables which thrive and mature well in the locality in which her home is located. Happy is the woman who is thus surrounded. She must understand the needs and peculiarities of the different members of her family. "We live, not on what we eat, but on what we digest." The purposes of food are first to furnish heat to keep the body warm; second, muscular and nervous power for work or play; third, material to repair the worn out particles of the body.

Were man so happily constituted as the ox, which will live contentedly on a diet of grass for an indefinite time, the housewife would have but to seek out a few articles of food which each member of the family could relish and digest, learn in what proportion they would meet the demands of the body and find the best means of preparing them, and the problem would be solved with little trouble. But scientists claim that man to be most healthy, happy and capable must have a reasonable variation in his dietary. It is believed that too great sameness long continued is one cause of the digestive troubles commonly found. Some authorities claim that raw fruit perfectly ripe and sound taken at the beginning of a meal is very beneficial both on account of the effect produced on the system by the fruit acids and for other reasons.

The habit of eating between meals is a source of great discomfort to the housewife in the country home. She often finds that when her family comes to the table they have eaten sufficiently of the luscious fruit which hangs so temptingly all about them and that they now care little for anything but bread, meat and sweetmeats. The habit of eating between meals is a very injurious one,

and every reasonable means should be used to prevent the young forming such habits.

Raw vegetables, such as lettuce, onions, tomatoes, radishes, cabbage, etc., should be freely used in their season, as they are here, in perfect condition, young, fresh and crisp. By taking them raw the system has the benefit of all the acids, mineral matter, etc., which they contain. Whereas they usually lose something, both in composition and flavor, when cooked. In general, mature vegetables are more easily digestible when cooked than in the raw state. The starch cells are enclosed in walls of cellulose, very little of which is digested by man, except the vegetables be young and the cellulose consequently tender. Cooking softens the cellulose and the starch, thus enabling the digestive juices to have more effect upon them, and the swollen starch cells burst their walls and thus expose a larger surface to digestive action.

In cooking vegetables it is better to use only enough water to keep them from burning, as a large amount of water dissolves much of the soluble matter contained in the vegetables. Prof. Harry Snyder in Bulletin No. 43, U. S. Department of Agriculture, gives conclusions drawn from experiments made in cooking potatoes in the following words:

"In order to obtain the highest food values potatoes should not be peeled before cooking.

"When potatoes are peeled before cooking the least loss is sustained by putting them directly into hot water and boiling as rapidly as possible. Even then the loss is very considerable.

"If potatoes are peeled and soaked in cold water before boiling the loss of nutrients is very great, being one-fourth of all the albuminoid matter. In a bushel of potatoes the loss would be equivalent to a pound of sirloin steak."

In cooking and serving carrots one can prevent great waste in food value and at the same time have a more palatable dish by using the water in which the carrots were cooked to make a sauce to serve with them. When the carrots are sufficiently cooked to be tender, remove them from the kettle, pour into the water in which they were cooked enough whole milk to make a sufficiency of liquid for the desired sauce. For each pint of this mixture, stir together dry in a tea cup, two level tablespoonsful of flour and the same amount of butter. Have the liquid boiling in the kettle and stir the mixture of butter and flour into it and continue stirring until it

becomes smooth and the flour is cooked. Season to taste, return the carrots to the kettle and let boil up in the sauce, then serve. One authority on the chemistry of foods says that in cooking cabbage the loss in food constituents is very great unless the water in which the cabbage is cooked be utilized. He says over one-half the mineral matter and more than one-third of the carbohydrates and nitrogenous matter are dissolved during the process of cooking. There are a variety of ways in which cabbage can be used raw, and to many persons it is equally palatable and probably more digestible when raw than cooked. Salad dressing may be made as described below.

Cold Slaw With Plain Dressing.—Season a moderately acid vinegar to taste with the following ingredients: One teaspoonful of salt, two teaspoonfuls of sugar and one-third of a teaspoonful of pepper. Sprinkle into the vinegar enough of this mixed seasoning to suit the taste and pour over finely shaved, cold, crisp cabbage just before serving.

Cold Slaw With Cream Dressing.—Put into a sauce pan over the fire two tablespoonfuls of butter and one of flour. When the butter melts mix the flour with it until smooth, but do not let it become brown; pour into this one cup of whole milk, stir until it boils a few minutes, season to taste with salt and pepper, then remove from the fire and gradually beat into it four tablespoons of vinegar. When perfectly cold beat into it one-third of a cup of thin cream or one cup whipped cream.

Hot Slaw.—Shave fine three-fourths quart of cabbage, cook slowly half an hour in a very little water, then add half a cup of vinegar, and salt and pepper to taste. Just before serving add one egg, one tablespoonful of sugar and two of cream beaten together.

Put a little butter into the spider, put in the chopped cabbage, add a very little cabbage as before, and when tender season to taste with salt and pepper and pour over it one-fourth cup of vinegar in which two tablespoonfuls of sugar have been mixed, let boil and serve.

It is easier to provide a varied and healthful diet in summer than in winter. But we can not refrain from again regretting the fact that the pernicious habit of eating between meals renders it so difficult for the country mother to banish the heavy desserts such as pastry and puddings from her table and put in their place the health

giving fruit and cool delicious melons in their very best condition on the farms where they are grown.

Some green vegetables can be dried for winter use and be as palatable as when canned and the process requires little if any more time and labor than canning. To dry corn, pick it when just in prime condition for roasting ears, husk, silk and score each row of grains down the center, then with a sharp knife cut off about one-third of the grain, then another third and then scrape off that remaining from the cob. Dry in a current of air quickly as possible; when apparently dry tie up in bags and hang behind the kitchen stove until thoroughly and completely dried, then put away for winter use.

To Dry String Beans.—Gather them when just right for present use, string and prepare for cooking. Spread in a shady place where the air circulates freely and when dry treat in the same way as the corn. Tomatoes are easily canned and their pleasant acid taste adds much to the winter fare.

To Can Tomatoes.—Gather ripe, red tomatoes, remove all objectionable parts, place the tomatoes in a pan, stew down and pour on a sufficient amount of boiling water to completely cover them, let them stand a minute and then drain off the water and pour cold water over them. When the tomatoes are cold the skin can be easily removed and the tomatoes will remain firm. Peel and cut in pieces, leaving out the core. Boil until perfectly tender and pour boiling hot into glass cans, which have previously been fitted with covers and rubbers, screw the tops down as tightly as possible, stand upside down and when cold screw down again. Set in cool dry place but do not allow to freeze.

In canning fruit or vegetables always try the cans with water to be sure they are tight, and have can covers and rubbers standing in boiling water while the material to be canned is cooking.

In choosing fruit for canning take that which is neither overripe or underripe and which has no blemishes, as it will have a better flavor and is more desirable for some other reasons. The color and flavor of fruits and vegetables is most perfectly retained by cooking slowly in small quantities in a granite or porcelain-lined kettle and stirring with a wooden spoon.

Fruit which requires long cooking should be cooked until nearly done before adding the sugar, as the sugar tends to harden the fruit and generally loses some of its sweetening power and darkens the

fruit. Such fruits as require only a little cooking and are easily broken may be cooked in a syrup.

To Cook Dried Fruits.—Prepare the fruit and wash thoroughly, then put to soak in a sufficient amount of cold water and cover it and let stand until it has absorbed water and become plump as before drying. Put to cook in the water in which it was soaked and cook until tender, then sweeten and remove from the fire.

Baked Beans.—Dry white beans are best soaked in cold water, the same as dried fruit, until fully distended, then put into a bean-pot or a stone jar with a cover, the seasoning at the bottom, covered with hot water and baked in the oven ten, twelve, or even fifteen hours, when they will be found very palatable and digestible. The water should be replenished as it cooks out, until they are nearly done, when they may be dried off in the oven.

It is easier to get a variety in meats in winter than in summer. While one would neither expect nor find it necessary to have fresh beef, pork and mutton all on hand at the same time, it is no difficult matter to have some of all during the winter season. Mr. Andrew Bass, who has had much experience along these lines, both in practical work and as a teacher, says that the best results are obtained by cutting the meat at once into the cuts in which it is to be used. Then pack the pieces in snow. Less of the meat juices are lost by thawing in the smaller than in the larger pieces. The vessels containing the meat are of course kept in a place without fire, where it of necessity freezes, the small pieces being much easier handled. Greater skill is required to make frozen meat palatable than cuts which have not been frozen, as the juices exude very readily when the surface thaws. To cook a frozen steak or chop, have a hot spider containing a little fat, place the steak in this and let it brown on both sides, then put into it a few tablespoonfuls of water, cover closely, draw to a cooler part of the stove and allow to cook through by means of the steam produced. When about done sprinkle salt over the surface, turn the steak, remove to a warm platter, pour the gravy over it and put a few spoonfuls of cream or hot water in the spider, stir and pour this into the platter. A frozen roast if first carefully thawed out and prepared, is usually best cooked as a pot roast, or roasted in a covered pan in the oven. In either case put a little water in the bottom of the vessel, let it be boiling on the range, place the meat in it, and when one cut surface has cooked a little turn and cook another until each cut surface is

seared, as this will help to shut in the juices and render the joint more moist. It is better to leave it unsalted and let each person salt it for himself when carved, as the salt also robs it of some of its juice. After it is seared, in either case put on the closely fitting cover and cook slowly until nearly done, then allow the water to evaporate and brown each surface of the meat before serving.

Fresh eggs in winter are usually a scarce article, but in the spring there are plenty of a good quality, and these poached or soft boiled make a pleasing variety, and wholesome, muscle-forming food.

FARMERS SHOULD RELISH CEREALS.

America's rich soil, energetic people, favorable climate and her mechanical and commercial genius have combined in the production of a large amount of cereal foods. The best varieties of these crops have been gleaned from the whole world, and in many instances they have been improved upon. Here, as in manufacturing, progress seems to be making rapid strides, and bids fair to hold a permanent place. Owing to the fact that farmers can so cheaply produce at home a variety of foods, they have not felt the need of rapidly taking up the use of even the better forms of cereal foods put upon the markets during the last one or two decades.

Doubtless their conservatism in this, as in many other things, has kept them from enjoying advantages which are within their easy reach. Most cereal foods are economical in that for a given amount of money a large amount of food material is purchased. They are healthful in that they lessen the tendency to eating too much meat, and they furnish all the elements needed to nourish the body. They have bulk enough to give the digestive organs their needed amount of muscular exercise, yet they rarely cause indigestion. Cereal foods tend to good morals, since when they form a goodly portion of the daily food there is no excessive stimulants to the body, nerves or mind. They are sufficiently bulky that there is little tendency to over eating and thus overloading the system with an abundance of flesh-formers, heat-formers, or ash, which must be carried out, requiring excessive labor on the part of the excretory organs. These foods are very appetizing, and since many of them are especially relished when eaten with cream, which is nowhere so abundant and inexpensive as on the farm, no class of people should appreciate them more than farmers.

THERE ARE MANY GOOD CEREALS.

Manufacturers rival each other in embellishing wrappers and

inventing novel names for their wares. Extravagant claims are made for these foods and much is said to induce the public to believe that by some peculiar method of manufacture an article far superior to simple plain oatmeal or rolled wheat has been produced. The fact is, there is in most cases more variation in price than in food value, and the relation between quality and cost is sometimes difficult to discover. The package goods have one merit, that is, the manufacturer is made directly responsible to the consumer. The oatmeal sold in bulk is practically the same in composition, and unless injured by long keeping and exposure, there is little, if any, discoverable difference in quality and flavor. The package cereals usually make greater claims for quick cooking than can be well substantiated. Granting that in such cereals, a portion of the starch grains have been crushed and partly converted into more soluble forms by means of heat, pressure and moisture, thus lessening the time required for cooking, yet experience proves that they usually have a better flavor when cooked half an hour, than when removed from the fire after ten minutes' cooking, as the packages sometimes direct. The carbohydrates of cereals are mostly in the form of small, hard starch grains which are not easily attacked by the digestive fluids.

Experiments made in feeding cooked cereals to domestic animals seem to verify the statement that little cooking renders them less digestible than when eaten raw, but a long, slow, thorough cooking brings about good results.

CEREALS CONTAIN ALL THE FOOD ELEMENTS.

Cellulose is the woody portion of plants. In such foods as spinach, the cellulose is young, tender and digestible. In grains the cellulose is found in its mature state and can hardly be classed as a food stuff for man, yet it plays an important part in giving bulk to the food and aids in preventing the tendency to too concentrated food. It acts as a mechanical stimulus to promote the peristalsis of the intestines. Bunge in his Physiological and Pathological Chemistry says: "While it is urged that the rapid and continual movement of the intestinal contents in consequence of the irritating action of the woody fibre prevents the complete utilization of the food," at the same time, he continues, "it appears to me that the advantages of food containing cellulose far out-weigh the drawbacks." All oily matters in grains are termed fats. These are similar in composition

to carbohydrates, but the fats are poorer in oxygen and richer in carbon and hydrogen. Therefore the heat equivalent of fats is much greater; that is, a pound of fat will produce more animal heat than a pound of starch or sugar. Buckwheat is a good example of a heat-giving cereal. It is more agreeable when used in cold weather and by those who exercise freely. It is used principally in the form of griddle cakes, though it is sometimes found in the markets in the form of a specially prepared cereal.

Cereals contain a small portion of the several mineral matters which are necessary for both bone and flesh, but there is usually no deficiency of most of these in our diet. Phosphorus is considered of much importance and special efforts are said to be made to secure it in milling.

HOW TO USE CEREALS.

One authority on physiological chemistry says that with the exception of preparations of corn and oats all the cereal foods lack the fat necessary to a normal diet. The proteids and carbohydrates occur in the proper proportions in them all. Since human beings select their food largely on account of flavor, why not supply the fat to the foods in the form of cream?

A dish of breakfast food, which is eaten under protest when served with milk, will be relished when cream is used. It is not extravagant because the cereal costs only a few cents a pound and the willingness with which it is eaten well repays the cost of the cream which on the farm is not expensive. To compensate for the lack of cream in oatmeal and cornmeal mush a garnish of fruit can sometimes be used. Strawberries, peaches, raspberries and bananas, each in its fresh state, are considered best for this purpose, as the flavors are sufficiently pronounced so that the two foods eaten together are very appetizing.

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PREFACE.

THE Members of the Agricultural Club of the University of Illinois have no better way to bring before the rural people of Illinois the kind of work they are doing here as students than through a publication of this kind. The Agricultural Club annually elect a board of editors whose duty it is to publish this book. It is the aim of THE ILLINOIS AGRICULTURIST to stimulate a desire for agricultural education among the farmers' sons. Other professions advance only through the work of their followers who have ability to think and reason, or in other words, those that have received good education. So is it also with our profession. The science of agriculture only advances through the work of the trained agriculturist. We cannot all expect to be leaders, but we have seen that it has been the man who used his mental faculties who has made a success of farming, and we can clearly see that this will be more and more true in time to come. To those desiring such an education we would recommend a four-years course at the University of Illinois. We are all loyal sons of Illinois, and for this reason, if for no other, we should attend her institution in preference to that of another state.

The Illinois Agriculturist is the annual publication of the Agricultural Club and represents some of the work done at the University by the Agricultural students. Our professors, especially those who are closely allied with agricultural work, and also some of the most prominent agriculturists of the state, have contributed valuable material. We wish to thank those who have thus kindly assisted us. We would also like to suggest to our readers to patronize our advertisers, for it was largely through their aid that the publishing of THE ILLINOIS AGRICULTURIST was possible.

If in any way this publication advances agricultural interest or stimulates a desire for an agricultural education we shall feel amply repaid for our work and time.

J. A. L.

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THE UNIVERSITY AND THE AGRICULTURAL COLLEGE.

By T. Ralph Miner, Class of 1900.

In 1862 Senator Morrill, of Vermont, introduced and secured the passage of a bill in Congress donating to each state a certain amount of public land for each senator and representative in Congress, which was to be used "for *the endowment, support and maintenance of at least one college whose leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to Agriculture and the Mechanic Arts; also to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

On account of this grant the state pays the University interest at the rate of five per cent. on about $460,000. In addition to this amount the state legislature appropriates different sums from time to time for permanent improvements and current expenses.

To secure the location of the University several counties entered into competition by proposing to donate to its use money or the equivalent. Champaign county offered a large brick building, about 1,000 acres of land and $100,000 in county bonds, and to this the Illinois Central Railroad added $50,000 in freight.

In consideration of these offers it was decided to locate the University between the cities of Champaign and Urbana, and this was done May 8, 1867.

With these donations and those from the state legislature, the present value of the entire property and assets is estimated at $1,600,000.

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*Taken from the catalogue.

The institution was incorporated in February, 1867, under the name of The Illinois Industrial University, but in 1885 the legislature changed the name to the University of Illinois. The University was opened to students March 2, 1868. There were present, the Regent, three professors and about fifty students.

Other buildings were added, and in January, 1870, a mechanical shop was fitted up with tools and machinery, and here was the *first* shop instruction given in any American university. Also, in March, 1870, the trustees voted to admit women as students.

The school has gradually added to its corps of instructors, and the number of students has gradually increased until now there are two hundred and ten instructors and sixteen hundred and fifty students. It has broadened from one school to four colleges and six schools.

In number of students the engineering college stands first. It is undoubtedly the best equipped school, and has the best faculty of any engineering college in the West.

The object of this college is to educate thoroughly the student for practical work in engineering and architecture. To carry out this purpose there are several courses offered, among others the civil, electrical, and mechanical engineering and architecture.

The students not only study the theory of the different phases of engineering, but they are required to do shop, practical, field and laboratory work, in order that they may learn more of the actual life of the engineer; also, to have some other views of the work than that derived in the class room.

The inscription over the entrance to the main building is "Learning and Labor." This is put into practice in the work of the entire University as far as possible. The hand is taught to work with the mind. Especially is this motto true in the colleges of engineering, science and agriculture.

In these colleges the student in the laboratories or shop, as the case may be, is helped to see the things that are told him by the professor in the lecture room. For example, the lecturer in chemistry tells the class in the lecture room that when sulphuric acid and common salt are mixed a gas is liberated. The student

may understand this at the time of the lecture, but if he is required to mix these substances himself in the laboratory, he will see the action take place and remember it.

Another illustration: The laboratory instructor gives the student a flower, and he is required to analyze it and then write a description of what he sees. Afterward he compares his description with the descriptions other men have made.

In the college of literature and arts there is no laboratory work proper, but an equivalent is found in the use made of the library. The purpose in this college is to give the student a general education and a general idea of all literature.

The schools that are under the supervision of the University trustees are more technical than the colleges, the purpose of these departments being to train the student who has a general education along some special line of work, such as medicine, law library science, etc.

The schools of law and library science have increased greatly in the number of students since they were started last year.

That part of the University that is of the greatest interest to the farmers is the agricultural college. This, although small in number of students, has a very strong corps of instructors, though they are somewhat handicapped by having so many different kinds of work to which attention must be given. The professors of the agricultural college, besides giving instruction to students, manage the affairs of the experiment station, and in addition to these duties are expected to attend as many farmers' institutes as possible.

This college, remembering the motive that caused the founding of the land-grant institutions, keeps as its purpose the helping of the industrial classes. The college of agriculture, thinking that a man needs to be educated in three ways, offers courses accordingly. The farmer needs general culture; he needs an education to teach him how to live; he needs a training to help him supply his daily needs, or a business education. The courses of study are divided into three parts—one-third is required science, one-third required agriculture, and one-third elective work. The science studies, such as botany, zoölogy

and chemistry, that are required are those that help the student of agriculture to better understand the technical agricultural studies.

The agriculturist should know something about the chemistry of the soil, that he may better understand the needed elements for a fertile soil. He should know something of botany, that he may better understand the life of the plants and the means by which they may be improved under his care. He should know something of zoölogy and entomology, that he may learn better how to combat the enemies working in his crops.

The technical agricultural studies have a direct relation to the problems of the farmer. In the freshman year, besides the science studies, which continue the entire year, the student begins by studying the history of some of the important breeds of live stock. Later in the term he is shown how to judge stock, or in other words, how to tell why one animal is superior to another.

The same term the student is given a general survey of the different fruits and their importance to the farmer. Also he is taught the general ideas of cultivation and the best methods and means of protecting the orchard.

The work of the second term is quite similar to that of the first term. The student continues his science studies, and with them takes up in a general way the work and business of the dairyman. The efficiency of the different separators are investigated very carefully. The student is required to test the different methods of creaming; also the keeping qualities of milk drawn from the cow with different degrees of cleanliness.

The third term's work consists of the study of the different crops and their influence upon the soil, and the care and feeding of farm animals.

The second year, and the rest of the course, the agricultural studies are partly elective. The student may choose along the line of work in which he is most interested. If this is in raising fancy animals, he may select studies bearing along that line, such as breeding and veterinary science. If he is desirous of becoming a horticulturist, he may select more botany and horticulture. To carry on the different agricultural studies the stu-

dents have access to the farms, where there is a good stud of Morgan horses, and good herds of Jersey, Holstein-Friesian and Short-horn cattle, and also a well-selected flock of Shropshire sheep.

The fields can be, and are, used by the students for experimental work in soil and crops. The orchards are used for the study of horticulture.

One part of school life that is not required, but that is taken advantage of by nearly all the students, is the work in the agricultural club. The students becoming desirous of furthering interest in agriculture organized the club in 1885. It was dropped after a short time, but was reorganized in 1896. Meetings are held every two weeks, and topics are discussed of vital importance to the everyday life of the practical farmer.

Further to promote interest and to extend agricultural education to all parts of the state, the club a few years ago established the paper that has now become its annual publication, THE ILLINOIS AGRICULTURIST The articles in this periodical are written by the students, professors, and, upon invitation, by some of the leading farmers of the state. It is the purpose to touch upon every phase of farm work in each publication.

INDUSTRIAL EDUCATION FOR GIRLS.

By Mrs. Mary Turner Carriel, Trustee of the University of Illinois.

Less than a generation ago the earnest thinkers of this state were disturbed by the bitter contest over the question of industrial education for men, a question which now awakens only enthusiasm and interest among the loyal people of Illinois.

Could the history of that struggle be placed before your readers, Mr. Editor, it would be perfectly incomprehensible, so completely has the question solved itself by the successful carrying out of those plans then so bitterly opposed. Today, the marvelous development of not only our state, but of our country, due to the help and experiments made possible by the founding and carrying on of these same institutions, is a complete vindication of those plans, and an honor to the brave men who endured so much ridicule from pulpit and press. That question is as completely solved as was the question of the revolution of the earth by Galileo hundreds of years before, and to this grand old prairie state belongs the honor and the glory.

Now comes up another question as vital to our interests—the question of Industrial Education for Women. This today is passing through the same period of ridicule and opposition, but not so bitter, nor will it be so prolonged, for our people have learned something by the experience of the past, and most of them are ready to welcome it.

There is no man's work and woman's work separate and distinct; what adds to the interest and advancement of one, adds to the advancement and added interest of the other. The sooner we recognize that there are no dividing lines, the sooner the American people will grow to their full strength and power. Circumstances, surroundings, and conditions should be the only limitations. They eat the same food, breathe the same air, need the same light of the sun, wealth adds to the comfort of both, and shame and crime mar the happiness of each.

We have men milliners and men dressmakers, and good ones they are too. We have women in all departments of life even to the river pilot and blacksmiths, and good ones too. How many merchants' wives have carried on the store and earned a good living for their little ones, when bereft of a father's tender care. More than one farmer's wife has carried on the farm, paid off the mortgage, sold the cattle and hogs at a profit, managed the orchard and made a happy home for herself and her little ones. More than one farmer has entered into his home, desolate and sad, gathered his little motherless ones around him, and with tender, loving hands cared for his dear ones until they have grown and could repay him for all his unselfish devotion, and could appreciate their father's lonely life and self denial. A man's work and a woman's work is the duty Providence has placed before them, and has given them the courage and the brain to do, each legitimately interchangeable, should necessity or convenience require.

Yet this article will treat of the Industrial Education of Women, as it relates to the home, for today schools, colleges and universities are open to both sexes, in the pursuit of all callings, mechanical or professional or literary. The home alone, the most important, receiving the least attention, the least help by way of buildings and apparatus for scientific teaching and investigation.

We have made rapid progress in the scientific plowing and harrowing of the fields and the feeding and care of the stock, and but little progress in the feeding and care of the children in the homes. Were it not for the clear sunshine and pure air of heaven, invigorating and filling their little bodies, fewer and weaker would be the lives to reach maturity. But do not the flocks and herds bask in the same sunlight and breathe the same pure air,—why do they need more scientific feeding and care to produce the best results?

We know now that the mysteries of earth, and air and water, the influence of heat and cold, the magic of plowing and harrowing require the brain of a chemist, the patience of an explorer, and the genius of an inventor to demonstrate to less gifted minds the rules and methods to follow for the best results.

Can you conceive of anyone today so ignorant as to claim "a farmer needs no special education for his life work; all he has to do is to put the seed into the ground, and nature does the rest." Yet, this is where many of our good people stand today on the question of INDUSTRIAL EDUCATION FOR WOMEN.

"Put our girls to work, let them learn of their mothers to cook, to wash and to bake, as our mothers did of our grandmothers." Ah yes, but why could not your boy learn of his father as you learned of your father, and he of his grandfather? Is there to be no advance along the lines of living for the people of America? Are the wonderful discoveries of chemistry to be used only for the flocks and herds and growing grains and for the cure of ills flesh is heir to, and not for the advance of mankind? The mysteries of the chemistry of food, its influence upon the body, and through the body upon the mind and soul, are far more incomprehensible to the average cook today than were the mysteries of time and seasons and moisture upon the fields and flocks of our grandfather.

Brain is the talisman, the magic key for success in all departments of life, brain healthy and strong to control the judgment, guide the hand, check the imagination, restrain the impulses. But if the brain be imperfectly, improperly and poorly fed, or weakened by neglect, how can it guide and check and control? Is its delicate gray matter any less susceptible to care and nourishment than is the udder of the Jersey or the flesh of the steer to grass and corn? We have made wonderful strides in the last century along mechanical and agricultural lines. The traveler of the eighteenth century could travel no faster and with no greater comfort than did the people of the first century. Abraham passing a thousand miles over mountains and plains journeyed exactly as did our fathers from the New England coast to the prairies of Illinois, save only he went more swiftly on the camel's back than our fathers did with horses and oxen.

If any young man commences farm life today with old time methods and old time implements, he has our sympathy if lack of money be the cause, but our contempt if it be lack of information.

So the girl who learns of her mother as her mother did of her grandmother, has our sympathy, but not our contempt, for public opinion in domestic science has not progressed to the same high standard that it has in the culture of the fields and the care of the animals. Public opinion has not kept pace with domestic science, which has made most wonderful progress in late years, and its teachers are only waiting, longing for the time when all will be benefited by its teachings.

The Industrial Universities have wrought miracles, not only for the farmer and artisan, but for all the people. The steam engine and the electric car of today are no greater blessing to the engineer and motorman than they are to the banker and lawyer, who ride behind. But what have they done for our girls, and through them for all mankind?

One of the greatest needs in our state today is a domestic science department in our State University, not for the girls alone, but for the benefit of the whole people. Every true man reveres his mother, and if that mother has gone to her long home, the greater is that love and reverence. Many men believe it to be disloyal to that mother to believe any cooking can equal hers. "All I ask is that my daughter may be able to cook as did my mother," he will say. The northern man, with his inherited taste for nutmeg and ginger for spice, as well as the southern man, with his inherited taste, through many generations, for allspice and cinnamon, says the same, and may God bless them both for the love which prompts the thought. But why not sigh for the horse and pillion and for the sedan chair? for the crooked stick for a plough and the sickle for a reaper? Is it disloyal to the memory of your father to discard the implements he thought useful and necessary?

Then did you ever think how much greater is the strain upon mind and muscle for the girl to learn what the mother can teach than it is for the boy to learn the rudiments of his life work? No wonder the girl is not so strong as the boy. Each is equally taxed in the school to the limit of their strength. The boy returns home after a long, hard pull indoors, often in a poorly ventilated school room, to outdoor sports or to the duties of the home, chopping the wood, milking the cow, feeding

the horses and the chickens—all in the crisp, pure air. With feet, ears and hands tingling he rushes from one duty to another and shouts and whistles from pure excess of joy in living. The girl goes from the same hard duties in school to the home, oftentimes as close and poorly ventilated, plays with the baby, a great delight even with weary brain and body; sets the table, washes the dishes, helps mother with willing, loving hands, but comes to her books for the evening study minus the oxygen, vim and renewed energy of her brother. Is it any wonder that the mother, with the little face before her, growing paler day by day, conscious of the wrong somewhere, taxes her own strength more and more so that her daughter may run and play in the outdoor air?

While the brother scornfully asks, "What are girls good for anyway? Nothing but to play tag and have a good time, while the boys do the work of a man on the farm." Let it no longer be said the American girl is the most attractive, the most intellec-lectual and the most gifted, but has the least strength, the least vitality, the least endurance of the daughters of the nations. The medicine, the nursing, the treatment, which will restore a German, a French, an English or an Irish maiden to health and strength, would only place an American girl in her coffin. When indoor work can be taught and practiced, with the least expenditure of nerves and muscle, and the largest returns from the best foods for the needs of each individual, then, and then only, can the American girl be equal to her foreign cousin in strength, and in endurance, as she now surpasses her in womanly magnetism and intellect.

The proper time and place for the study of domestic science is with other intellectual and scientific studies, by a school girl, within school walls. Let her be educated in our schools, colleges and universities, for there is no sex in science and literature, and let her at the same time and in the same place be scientifically and systematically trained for her life work, so that with her diploma she may carry to her home the brain and hand for any work, in any department of life nature may have intended for her; always hoping, always believing that the highest, noblest, truest life for woman, not changed by peculiar

circumstances of bereavement, surroundings or genius, is to be found in the home with all its pleasures and duties. The Armour Institute in Chicago, and the Bradley Institute at Peoria, have already begun the good work. Only those who have visited these institutes can understand the great good they are doing. But this is not enough. Has this great state, with all its varied interests and great wealth, with its generous provision for the education of the civil engineer, the architect, the chemist, the farmer and the professional man, with its generous provision for experimenting in the care of the flocks and herds and soils, no money for the training of the home keepers of the future? Where is the domestic science building so long needed, so long hoped for, so long believed in by the intelligent people of Illinois? Who has seen its walls rising upon the campus of our State University? It has not yet been seen, but with the hearty recommendation of our generous governor, in his message to the present legislature, we believe it will be seen before another year passes. Our legislators, guided by the wish of the governor and their own judgment, will provide for the care and training of that which is nearest and dearest to the heart of every man—our girls.

SOME COMMON CHEMISTRY FOR THE HOME.

By C. G. Hopkins, Ph. D., Experiment Station Chemist.

Chemistry, which was long known as the "Black Art," is one of the oldest of the natural sciences. It treats of the very primal elements of which all matter is composed. To study a substance the chemist divides it into two different substances, and then, if possible, divides each again, and subdivides, and resubdivides, until at last a *something* is obtained which cannot be divided into two different things. This something is called an *element*, a chemical *element*. The element is the basis of matter. Here our investigation ceases. As far as the human mind can penetrate the element is the ultimate. We may still interrogate with whys and wherefores, but the only answer we receive is that it is because it is.

It is important to know that there are only about eighty of these chemical elements, and that every substance known to man is composed simply of one or more of these primary elements. Copper is an element, because pure copper contains nothing but copper. Gold and silver, sulphur and iron, lead, tin, and zinc are common elements. Mercury, or quicksilver, is an element which is liquid under ordinary conditions. Some elements exist in the form of gas, as oxygen and nitrogen, of which the air is chiefly composed.

While there are more than eighty chemical elements known to science, only about two dozen of them are to be met in common every-day life. The elements lead, silver, mercury, copper, tin, gold, aluminum, nickel and zinc are familiar to us because they are among the common metals.

The following chemical elements compose the fertile soil, the crops it produces, all vegetable and animal foods, and even the animal body, namely: Carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, iron, silicon, calcium, magnesium,

potassium, sodium, and chlorin. Of these thirteen elements the first four mentioned, carbon, hydrogen, oxygen and nitrogen, are of especial importance in the chemistry of the farm and home. The air we breathe, the water we drink, the food we eat, the clothing we wear, and the fuel we burn, contain but very little besides these four elements.

A chemical compound is composed of two or more elements which are chemically united,—united in such a way that the elements themselves are no longer easily recognized. For example, water is a compound of the two elements, hydrogen and oxygen, both of which are gases under ordinary conditions. The uniting of elements into a compound is one form of chemical action, a process which very commonly evolves heat. Thus when hydrogen unites with oxygen it is said to burn, heat is given off, and water is formed as the product of the combustion. By means of the electric current water may be decomposed into the two elements, hydrogen and oxygen. Pure water contains nothing besides these two elements, but the water which we obtain from streams, springs, or wells always contains more or less foreign matter in solution.

One of the most common of these dissolved substances is a compound known as the acid carbonate of lime. When the water is boiled this compound is decomposed; carbon dioxid passes off as a gas, and the ordinary lime carbonate appears as an insoluble sediment, which is usually attached to the walls and bottom of the vessel as a crust or scale. On long standing this same decomposition occurs without the water being boiled, and its appearance in water pitchers is common. This troublesome deposit, or scale, may be quickly dissolved with a small amount of hydrochloric acid (muriatic acid), a compound of the elements, hydrogen and chlorin. The acid acts upon the lime carbonate to form the gas, carbon dioxid, the liquid, water, and the solid, chlorid of lime (calcium chlorid), which is soluble. Lime deposits may thus be removed from vessels of glass or "earthenware," or from those with porcelain or "agate" linings, but the hydrochloric acid must not be used in metallic vessels, as tin, copper, or iron, as it will dissolve the metal.

While it is true that the foreign substances usually held in

solution in drinking water are of a nature harmless to health, yet the fact is here emphasized that water is one of the principal carriers of disease germs, and that the water supply for the family use is a matter of no small importance.

At high temperature water becomes a gas; at low temperature it is a solid. Under ordinary atmospheric pressure water boils at a fixed temperature (100° Centigrade; 212° Fahrenheit); that is, if water is boiling gently it is just as hot as it will be when boiling violently, and foods which may be cooked in boiling water will be cooked just as rapidly when the water is kept at a gentle boil as when it is fast boiling away into steam.

The important element in most of the fuels we burn is carbon. Coal is mainly carbon, and wood contains a large amount of that element. When wood is heated to a high temperature the other elements which it contains in important amounts, that is, hydrogen, oxygen and nitrogen, are driven off, and the charcoal which remains is nearly pure carbon. Sugar is a compound of carbon, hydrogen and oxygen. When sugar is heated the hydrogen and oxygen are driven off, mainly in the form of water, and the charcoal which remains is pure carbon.

When carbon burns it simply makes a chemical compound with the oxygen of the air. This compound of carbon and oxygen is called carbon dioxid. It is a colorless gas which in large quantities is dangerous to animal life, but for the growth of plants it is very important and necessary. The general process of combustion is very simple, and certainly a matter which should be understood by those who have the management and care of fires for cooking or heating, or of lamps for lighting. In the combustion of carbon the element oxygen, which is contained in the air as a gas, enters the stove or furnace, there it unites with the element carbon to form the compound carbon dioxid, which passes off as a gas through the stove pipe or chimney. If the supply of oxygen is too small the product of combustion is not carbon dioxid, but carbon monoxid, which is an extremely poisonous gas. Appreciable quantities of many gases, which in larger amounts are known to be injurious to health, are often permitted in living rooms by authorities on the subject, but the air is condemned if the presence of carbon monoxid can be

detected. One per cent. of the gas is sufficient to produce death, while only traces of it are dangerous to health. Great care should be taken to see that the gaseous products of combustion have free passage through the stove pipe and chimney. The use of a damper in the stove pipe by which this passage may be too nearly cut off is a constant source of danger. It is much safer to check the fire by a proper use of the vents of the stove and pipe.

Such fuels as gasoline and kerosene, or coal oil, are composed of compounds of hydrogen and carbon. These compounds are called *hydrocarbons.* When they are burned the carbon unites with the oxygen of the air to form carbon dioxid, while the hydrogen unites with oxygen to form water. If a vessel containing cold water be placed over a gasoline flame the water produced in the combustion condenses to the liquid form and will be found to collect in drops on the outer surface of the cold vessel.

The necessity for oxygen in all ordinary combustion is absolute. Something of its importance may be understood from the fact that to burn one ton of carbon requires the oxygen from fourteen tons of air, that is, in the combustion of one ton of good coal fourteen tons of air must enter the vents of the furnace and fifteen tons of gases must pass through the chimney.

Of all known substances air is the most common. It is the one thing which is everywhere present over the face of the earth, and it is the one thing with which, between the time of birth and death, the living animal must be *constantly* supplied. Under the ordinary conditions air is a gas, or rather a mixture of gases. Pure dry air consists of about seventy-eight per cent. of nitrogen, twenty-one per cent. of oxygen, a very small percentage of carbon dioxid, and nearly one per cent. of that recently discovered element, *argon.*

Oxygen, it will be remembered, is the element which supports all combustion, and without which no fire will burn. Oxygen is also the element which the animal system requires of the air we breathe. Indeed the animal life is sustained by the process of combustion. While a small amount of mineral matter in the food is necessary, especially in the formation and repair

of the bones, and a moderate supply of nitrogenous material is needed for the growth and repair of all other working parts of the body, by far the largest part of food is carbonaceous matter, which is burned in the body in part to furnish heat, but more especially to produce the form of energy necessary to perform work,—work done by the heart and other internal organs as well as manual labor.

The oxygen which is drawn into the lungs and enters the blood unites chemically with the carbon of the carbonaceous food to form carbon dioxid, which is then given off through the lungs. Air which is exhaled from the lungs of course contains more carbon dioxid and less oxygen than ordinary air. Indeed if air be retained in the lungs for half a minute or more this change in its composition becomes so great that it will no longer support ordinary combustion. If we remember that all combustion, whether it takes place in the animal body, in the oil or gas lamp, the gasoline stove, the oil heater, the kitchen range or the furnace—that all combustion draws on the supply of that necessary element, oxygen, then we begin to understand the importance of proper ventilation, that is, of providing a constant and sufficient supply of oxygen. Sometimes people think they should not allow any "night air" to enter the house. Imagine a diver working at midnight at the bottom of the sea and giving orders to have no "night air" pumped down to him. After the sun goes down night air is all the air we have, and it is not essentially different from day air.

The use of baking powder is one of the important applications of chemistry in the kitchen The value of baking powder is due to the fact that it contains carbon dioxid which can be liberated in the dough as a gas at the proper time to render the cakes or biscuits light and porous In the best known baking powders bicarbonate of soda (saleratus) and acid tartrate of potassium (commonly called cream of tartar) are the active chemicals which are used. When mixed together in the dry condition these compounds do not react with each other to liberate carbon dioxid, but as soon as the mixture becomes moist the action begins, carbon dioxid being liberated as a gas and only sodium-potassium tartrate (Rochelle salt) remaining as a powder.

In buying baking powder there are two things to be considered, of which the first and the more important is the by-product that is left in the food when the powder is used. As stated above, with cream of tartar baking powder this by-product is Rochelle salt, which is harmless to health in the quantities which remain. Powders which leave by-products containing alum are probably the most injurious. The second point to be considered is, of course, the quantity of carbon dioxid which the powder will liberate. There are two safe ways of obtaining good baking powder. One is to buy only that which is guaranteed to be a pure cream of tartar baking powder. But the better way is doubtless for every housekeeper to make her own baking powder. This is a very simple matter. Buy two pounds of good cream of tartar and one pound of bicarbonate of soda. Add to the cream of tartar one cup of corn starch or corn flour (wheat flour will do) and sift through the kitchen flour sieve two or three times, then add the pound of soda and sift the whole four or five times and keep in air-tight vessels, such as glass fruit jars.

The starch or flour is added as a "filler" to prevent the soda and cream of tartar from coming in actual contact and liberating carbon dioxid in case traces of moisture should be present. This makes nearly four pounds of the best baking powder known, and the total cost need not exceed one dollar.

BACTERIA OF THE SOIL.

By J. A. Latzer, Class of 1899.

Before considering the subject we should get some idea of what bacteria are. Many of our readers may know, but there are thousands, yes, millions of people that have not the least conception of a bacterium. This is not a wonder when we consider that its appearance to the human eye was only made possible by the invention of the compound microscope, which was only a few decades ago. There are no doubt still forms of bacteria known to exist which have not yet been seen, even with the most modern and best instruments. We hope the time is not very far off when all such forms can be seen, either with the aid of better microscopes or by better methods of staining.

Bacteria are living plants, many of which have the power of locomotion. Most of them multiply very rapidly, varying with the kinds. It is estimated that upon an average, bacteria multiply once in from one-half to one hour. Their shape varies from little spheres to filaments or threads. It is hard to give general characteristics, as those who are familiar with them know, because characters vary greatly in different species.

One result of the activity of bacteria is a chemical change, that is, they produce some chemical product. This product may be of value to man or it may be to his detriment. An example of this latter is the production of poison by disease germs within the body, in this way causing death. On the other hand the farmer has to depend upon certain kinds in the soil for his crop, and it is this phase of the topic to which I shall mostly confine myself.

Before it was possible for man to live or plants to grow, the rock which was formed after the earth had cooled had to be transformed into soil, and many agencies have been at work in this soil formation. Among the leading scientists, such as Wiley and

others, the belief is, and with good reasons, that bacteria took, and still take, active part in the decay of rock, that it is through their action that rock is made somewhat soluble, and easily crumbles or breaks up into fine particles which we generally call soil. They assist not only directly by absorbing parts of the rock as food, but also indirectly by the liberation of acids, thus dissolving the soil particles.* Taking into consideration that food enters the plant only in the liquid form, it is evident that these bacteria dissolving or helping to dissolve the soil particles perform a great work. The amount of material thus made soluble will to a great extent depend upon the number of bacteria, but also upon the kinds, in the soil.

The number of bacteria in a soil sample will depend in part upon the distance it was taken from the surface, the amount of humus, and also upon the crop grown upon the land. In this connection it may be of interest to mention the results of an experiment carried on at the University by L. D. Hall and myself. This was done as a part of our regular class work in the bacteriological laboratory. The object of the experiment was to determine the number of bacteria in different kinds of soil and at different depths. Our tests were from plats as follows: Blue grass sod, clover sod, soil from corn field, and dead dog soil upon which corn had been grown. The depths at which the samples were taken were: one inch, four inches, twelve inches and twenty-eight inches.

Space will not permit me to give a detailed account of the experiment, so I will merely give the conclusions. We noticed that the soil at four inches contained a larger number of bacteria than the first inch. This is probably due to the larger amount of light to which the surface soil is exposed, though there may be different agencies concerned in bringing about this difference. The clover soil had the largest number of bacteria to the gram of soil, blue grass sod coming next, while the dead dog soil had the fewest. Clover land is especially rich in bacteria at the greater depths, such as 12 and 28 inches, due probably to the longer roots of the plant as well as the development of nodule

*Soil Ferments Important in Agriculture, by H. N. Wiley, Journal of Franklin Institute, 1897, Jan.-June.

producing bacteria. Clover and blue grass sod are generally rich in humus, and this to some extent accounts for the fact that they surpass corn ground in the number of bacteria. The difference in the number of bacteria in dead dog soil and in ordinary corn ground on the same plat was not very marked, the greatest difference being near the surface. In all cases the number decreased gradually after the second depth.

The results of this experiment were not as accurate as they might have been, due partly to the limited amount of time, also to crude methods of soil sampling and the want of good culture media. Gelatin could not be used owing to the rapidity with which it liquified, so nutrient agar was resorted to, but this is not as good a medium for general purposes as the gelatin. Time did not permit the determination of kinds.

The kinds of bacteria in the soil varies greatly as does their work. Before taking up the effects of bacteria upon plants and preparation of plant food the source of plant food will be referred to. The mineral constituents of plant food are abundantly supplied through the soil, and there is seldom a lack of this kind of food. The other constituents of plant food, carbon, hydrogen, oxygen and nitrogen, still remain to be considered. The first three of these, that is, the carbon, hydrogen aad oxygen, are abundantly supplied in the water, and carbonic acid gas of the air. Nitrogen exists in the air in enormous quantities. The air is composed of about 79% of it, but great as is this quantity the plant has no power to utilize any of it directly. The plant only takes nitrogen in through the roots in the most soluble form, viz., nitrates.

Our agricultural plants constantly draw on the limited supply of nitrogen in the soil. Small quantities of nitrogen are brought to the earth by rain, being formed into nitrogen compounds through electrical discharges. Often considerable quantities are supplied by the application of commercial fertilizers, but these quantities are very small when we consider the amount that is taken from the soil by a single crop. The refuse of the plant that remains on the field as roots, stalks, etc., contain a large amount of nitrogen, but not in form that can be utilized as plant food. Through the action of bacteria upon this organic

material it is possible to use the nitrogen, for they change it to nitrates. This process is quite complicated and it undergoes several changes before it reaches the form of nitrate. The first stage is the decomposition of organic material into ammonia or some of its compound. The plant generally also possesses some carbohydrate, such as starch or sugar. The decomposition of these materials also goes on in the soil, and when present in large quantities the soil has a tendency to become "sour," * or too large an amount of acid is liberated and thus hinders the work of the former organisms, as most bacteria grow only in neutral or slightly alkaline media. In case the soil does become sour the application of lime to neutralize the acid greatly aids in the development of these bacteria and also their work.

The organisms that effect the transformation of organic matter to nitrates belong to the general group known as nitro-bacteria,† these being divided into three genera and many different species. Their work is accomplished in three stages—(1) the formation of ammonia, or the process of ammonification; (2) the change of ammonia to nitrous acid or its compound, or the first stage of nitrification; (3) the change of nitrous to nitric acid, or the second stage of nitrification. Each of these processes are necessary to produce this valuable result, and each part of the work is due to special kinds of bacteria.

The older investigators thought that the process of ammonification was due directly to a spontaneous chemical change, but quite early it was noticed that bacteria are found in large numbers where putrefaction takes place. It was, however, left for Pasteur to prove that this is actually due to living organisms. These organisms‡ are found abundantly in the surface soil, rain water, and even in the air. Among the present known species *Bacillus mycoides* is the most active in the production of ammonia. In addition to bacteria there are moulds which are engaged in the same kind of work. These are, however, not very active compared with the bacteria, although in acid soils, which generally occur in swamps and forests, where bacteria cannot work, these moulds are the producers of ammonia.

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*Delaware Bul. No. 40, Page 10.

† Journal of Franklin Institute. Wiley. P. 296. ‡ Ibid.

Experiments upon the process of nitrification dates back to 1871-1873, when J. H. Gilbert found that the ammonia salts applied to the soil, passed off in the drainage water as nitrates. *In 1878 Schising and Müntz thought this was due to organisms, because by passing chloroform vapors through the soil the process was checked. It was, however, not until 1891 that any isolations or critical studies were made. It was then also found that nitrification takes place in two steps, by separate but closely related organisms. The first of these steps is the changing of ammonia into nitrous acid; this is done without any very great loss of ammonia except when it is present in large quantities. It is evident from this that ammonia fertilizers should not be added in large quantities on account of the loss of nitrogen through the work of these organisms when the material is abundant.

The organisms of this first step are rather large and vigorous, being about $\frac{1}{25000}$ of an inch in diameter. They are globular or somewhat ovate. The last step, or that changing of nitrous to nitric acid, is due to an organism which is only from one-half to one-fourth as large as the one above mentioned. This step follows the other very closely and there is seldom any nitrous acid to be found in the soil, but when the bacteria are separate the work of each is apparent.

These processes being due to definite organisms the laws controling nitrification are the laws governing the development of these organisms. If the conditions are perfect there will be only traces of ammonia, nitrous and nitric acid present. The amount of humus or organic matter in the soil is a condition that effects nitrification. The acidity, the condition of cultivation, and aeration are also great factors in this process, because these organisms grow only in the presence of oxygen. Experiments at the Delaware Station show that the effect of cultivation is a marked increase in nitrification and is in proportion to its thoroughness and frequency. Conditions of moisture are essential; some moisture must be present, but when present in too large quantities the activity of the bacteria is suspended and often denitrification takes place.

*Delaware Bul. No. 40.

Nitrates are very soluble and thus easily carried away in drainage water. To prevent this the soil ought to be constantly cropped, weeds or any other plants will answer the purpose to prevent this loss. Now when the weeds are decaying on the soil the nitrogen is brought back as organic nitrogen, and will not be lost. It is not always best to too much favor the conditions of nitrification, because the supply of humus would soon be exhausted and the fertility of the soil gone.

We can see whatever method is practiced the supply of nitrogen is bound to decrease. Farming has been going on for centuries but still our supply of nitrogen is not exhausted. Air contains large quantities of nitrogen, and it was finally thought that certain plants had the power of absorbing nitrogen like carbonic acid gas through the leaves. The experiments of Lawes * and Gilbert proved quite conclusively that no nitrogen was gained by such plants either through the leaves or stems. In 1886 Hellriegel, and somewhat later Lawes and Gilbert, found that the leguminous plants did gain nitrogen from the air, either directly or indirectly, but not through the leaves or stems as formerly supposed, but through the roots. It was also noticed that in all cases where nitrogen was gained enlargements on the roots were present, known as root tubercles or nodules. These are very irregular is shape, size and position, but generally contain bacteria. Nodules are gall-like† growths caused by the action of bacteria upon the roots. The plant and bacteria appear to exist in a state of symbiosis, that is, one helping the other. These bacteria have the power to gain the free nitrogen of the air, but they may also get their nitrogen in the combined form from the soil, usually from the most readily available source. This was proven by A. C. Beal's experiment carried on here at the University in the spring of 1897.

The bacteria occurring on different leguminous plants are different, but closely related, and the work they perform is almost identical. Separations or pure cultures of these bacteria have been made by Nobbe and are known as nitragin. This

* U. S. Bul. No. 22. Agricultural Investigations at Rothamsted, England. P. 122.

† S. H. Vines. Text Book of Botany. P. 713.

nitragin is put up in 8-oz. bottles and sold for the purpose of applying to the land at the time of growing of that particular leguminous crop. Already nineteen of these forms have been separated. A complete description of nitragin and its method of preparation and application is given in the Journal of Society of Chemical Industry, Nov. 30, 1896, page 767, under the title, Production of Inoculating Materials for Use in Agriculture, and in a more recent article in Science, Jan. 7, 1898, Recent Progress in Agricultural Chemistry.

It is apparent from what has been said that the bacteria of the soil are of much importance in the production of our food, but it is to be regretted that they are not more studied by the class of people to whom they are the greatest benefit, the farmer.

THE IMPORTANCE OF LEGUMINOUS CROPS TO AGRICULTURE.

By L. S. Robertson, Class of 1900.

There is no family of plants that furnishes to our agriculture so many important crops as does the Pulse Family, or the Leguminosæ. There is said to be over 6500 species in the family, and these are scattered around the world in all climates and in all kinds of soils. Only those particular ones that are cultivated or grow wild with us will take up our attention, although these represent but a small portion of the uses and wealth of the entire family. The family possesses many peculiarities which make it an interesting object of study outside of its real commercial value. Among these peculiarities may be mentioned the fact, which gives the family its name, that the fruit is in almost every case a legume or pod, the so-called sleep movements of the leaves of some of the species, the peculiar shape and construction of the flower by which cross-fertilization through the agency of insects is made necessary, and the recently discovered root tubercles, whose function will be discussed later.

Illinois, through its central location in the temperate zone, and by virtue of the many different soils found within its borders, can grow profitably many of these crops. In our state none is of more importance than the Red Clover. On account of the great dependence of our farmers upon it it has been called "The red plumed commander-in-chief of the manurial forces." Red Clover (*Trifolium pratense*) was known and prized as many as 2000 years ago by the Greeks and Romans, but it cannot be said to have been cultivated until used in England about 1633. It is found in Europe, N. Africa, Siberia, W. Asia to India, and was introduced into America before the Revolution. The plant is so common that any description of that part above ground that we could give would hardly be worth while, so we will at once take

up the root. We find it to be a much-branched tap root that rarely extends less than two feet below the surface, as in moist compact land or when the surface is very rich, while where the soil is open and inclined to be dry it is not uncommon for the roots to extend downward six feet or more. Various experiments have shown that fully one-half of the weight of the clover plant is below the ground in the form of roots. Red Clover likes best a soil of clay loam rich in lime, but will thrive better than Timothy and most other grasses where the soil is sandy or gravelly. It is grown profitably in most all parts of the United States, being most common in the northeastern part from Maine to Iowa, but good results are reported from the West and South. In Kansas it sometimes kills out in dry seasons, but in favorable seasons yields more than the average crop of the eastern states. When the land is once seeded it never runs out, as in the East, but thickens and spreads continually. Reports from Georgia and Mississippi say that it is one of the most valuable of forage crops for the southern farmer.

Mammoth Clover is quite similar in appearance to the early Red Clover, but it blooms later, which makes it better to grow with Timothy. It is more inclined to spread than the early variety, the stems are larger and more woody, and the leaflets are narrower and often destitute of the light spot. Mammoth Clover is generally conceded not to be as hardy as early red clover. Alsike Clover is a smoother and more delicate plant than early Red Clover. The stems are weak and branching, bearing the oblong and toothed leaflets. It likes a moist soil containing some clay. It stands dry weather well and is not apt to winter kill. The flowers furnish nectar in great abundance, hence it is a favorite with bee-keepers.

White Clover is found in all our pastures. It is extremely hardy, defying excesses of cold, heat or drought, and will flourish where other grasses wither.

The Cow Pea (*Dolichos Cheninsis*) was introduced from southeastern Asia into the Southern United States sometime last century, and has been grown there abundantly ever since. It is not a success at the North. * This plant will grow on any

* Circular No. 45, Ill. Exp. Station.

soil, either sand or clay, "too poor to raise anything else," if it be not too wet. It is especially valuable as hay on account of its leaf and slender stems. The growth of vines is very rank. The roots are small, nearly five-sixths of the weight being above ground. For this reason the stubble is not of as much value as a fertilizer as that of red clover. The seeds are relished by cattle and hogs, but with our present methods of harvesting it is a very expensive process to gather them. The yield of seed is sometimes as high as 35 bushels per acre.

The Soja Bean has been but recently introduced from Japan into our northern states. It is not a success in the South. Like the Cow Pea it will grow on any soil, and is relished by stock both for its seeds and vines. The hay is inferior to that of the Cow Pea on account of its heavy woody stems and because the leaves readily fall off. Like the Cow Pea also, the roots are small and not of much value as a fertilizer.

Alfalfa or Lucerne is a native of Western Asia. It was introduced into Southern Europe in very early times where it played an important part in Roman agriculture. From here it traveled to Spain and was introduced by this country into South America, whence it found its way into the United States through California. It is cultivated very extensively in the Western States on account of its enormous yield of hay. Under favorable conditions as many as four cuttings have been made, the first yielding about 2 tons per acre, the second 2½ tons, the third 1½ tons and the last about 1 ton. It requires a fertile soil, an abundance of water, and in order to cure the hay, a very dry, sunny climate is necessary, which is one of the reasons why it cannot be successfully grown to any extent in Illinois. Alfalfa is the deepest rooting plant known to agriculture, hence it is especially valuable in bringing up elements of plant food from the lower layers of the soil. The roots sometimes penetrate as many as 12 to 15 feet from the surface, which aids it materially in withstanding drought. The plant is slow to start and in early life feels the competition of weeds. Of the other Leguminous Crops we occasionally see Crimson Clover, Vetch and Lupine, but they do not form agricultural crops of any great importance to us, so we will omit any description of them.

The soil may be termed a storehouse which contains the mineral food materials required for the growth of plants. The most important of these elements are potash, soda, magnesia, lime and phosphorus. If we take the mean dry weight of a surface foot of soil at 80 pounds, and the percentage of these ingredients as given by * Hilgard, we will find these elements available as plant food in the surface foot per acre in the following quantities:

Potash in surface foot per acre	3.76 tons
Soda in surface foot per acre	1.58 tons
Magnesia in surface foot per acre	3.92 tons
Lime in surface foot per acre	1.88 tons
Phosphorus in surface foot per acre	1.97 tons

Now from the amounts of these same elements as found by Wolff in 1000 lbs. of clover hay we see that with each ton of clover hay taken from the soil we take

Potash	39 lbs.
Soda	1.8 lbs.
Magnesia	13.8 lbs.
Lime	38.4 lbs.
Phosphorus	11.2 lbs.

Now if we assume that we are to take from our land two tons of clover hay per year, with no return to the soil, we would have

Potash enough for 96 crops.
Soda enough for 830 crops.
Magnesia enough for 283 crops.
Lime enough for 48 crops.
Phosphorus enough for 180 crops.

It would seem from these results and from the facts that on an average about four feet of the soil are available for clover roots, and that with our present system of manuring much of the ash of plants is returned to the soil, that the farmer need give himself no worry concerning the conservation of these elements, yet by experiments conducted by Sir J. B. Lawes we see that where crops are grown year after year upon the same land with the addition of no nitrogen-bearing manure, the crops were able to produce larger yields and extract more nitrogen from the soil when mineral fertilizers were added. Ground bearing six crops of clover in 22 years, with 1 of wheat, 3 of barley, and 12 years

* Paper in the tenth census of the United States.

fallow ground, gave without fertilizers 30.5 pounds of nitrogen per acre, but with mineral fertilizers 39.8 pounds. Experiments conducted on the same plans with wheat, barley and beans give essentially the same results. For some reasons these large stores become unavailable in the required amounts after the growing of the same crop on a soil for several years, and we have here a good argument for the rotation of crops.

The other elements essential for plant growth are classed as non-metallic elements. Of these oxygen occurs in great quantities in the air and water of the soil, and in combination with all the metallic elements. Where the soil is in good tilth and in good condition as to moisture, oxygen will always be present in abundance. Carbon occurs in the soil as a part of the humus or organic matter, in carbonates and also as carbon dioxide, but as the plant depends upon the CO_2 of the air for its food supply, and this is essentially a constant quantity, so it need give the farmer no trouble. Nitrogen occurs in the soil as a part of the humus and decaying animal and vegetable matter. It also constitutes 79% of the atmosphere, but in neither of these conditions is it available for plant food. The agency of some microscopic life is necessary in both cases before the nitrogen comes to be in the form of nitric acid and nitrates, when it can be used by plants. If we take .15 per cent. as the amount of nitrogen in the surface foot of soil, which would probably be considerably too low for our prairie soil, we would have a supply of 5227 lbs. for the surface foot per acre. King gives the amount of nitrogen used by a clover crop of two tons per acre as 102 lbs. At this rate our supply would be sufficient for 52 crops, provided that the nitrogen supply remained fixed in the soil, and provided also that the clover got its supply from no other source than the nitrogen of the soil. But this nitrogen is not all available for the use of plants, and in its available form it is very soluble and is apt to be washed away out of the reach of roots before it can be used. We know that nitrogen is a very essential element to any organic life and that it is very easily wasted in its available form. For these reasons it is necessary that we be sure that we have a supply of it before we expect to raise good crops. A very small amount of nitrogen is precipi-

ated upon the soil by rain and dews. This has been determined by Lawes and Gilbert to be less than 5 pounds per acre per annum, quite insignificant when we consider the amount we take from the soil in a single clover crop. There is, however, another very important source of nitrogen for all Leguminous Crops which will be taken up in the following paragraph. Enough to remember here that we have in the clover crop, including the roots and stubble, a supply of nitrogen certainly not to be considered insignificant in reclaiming a nitrogen-poor soil. Whenever we plow under clover sod we are putting into the soil an immense amount of organic matter which will prove of benefit to it in various ways. We have material here which will furnish an abundant supply of humus for absorbing and holding moisture, for supplying nitrogen and for improving the texture of soil. Then if our soil is especially poor in its capacity for holding water and manures we can plow under our whole crop while it is yet green and we have made a still greater addition of organic matter which will, when it has reached the proper stage of decay, give results which will be correspondingly greater. In this way many a hungry and leachy soil has been brought into a suitable condition for supporting large crops. Of course we do not turn back upon the soil any of the mineral elements of plant food but those that were there before; but in the case of deep-rooting crops like Clover and Alfalfa we do put into the surface foot of the soil food material that has been brought up from lower depths where our ordinary crops would not be able to reach them. Aside from the turning over of the surface foot of roots we leave in the soil an extensive system of somewhat fleshy roots, which upon their decay leave throughout the soil a system of channels which allow the water and air to circulate freely through it. By the improvement of the tilth of the soil through the addition of humus we increase the water-holding capacity of the soil, and in times of excessive moisture the water runs off easily, while in dry times the capillarity is much increased and water comes up from the lower soil laden with mineral salts, which, as the water evaporates, are left near the surface. The process by which the organic matter, spoken of in the preceding paragraph, is changed to humus and the

humus then changed to available nitrogen has to do with a study of the microscopic life of the soil. The soil is not a dead mass of material as is sometimes supposed, but is teeming with life too small to be seen with the naked eye, but important nevertheless. Many of these minute denizens have been proven to be active agents in putrefaction and decomposition of organic material, and upon them the maintenance of the fertility of the soil depends, as they convert material into forms suitable for assimilation. There are two classes of these microscopic inhabitants of the soil, one class has an oxidizing action assimilating organic matter and giving rise to carbonic acid and water; the other has a reducing action causing the loss of nitrogen. This loss, however, is more than neutralized by a recently discovered type that fixes the free nitrogen of the air. The process of nitrification is the conversion of the nitrogen in its different forms to nitrates, and as this is the form in which nitrogen is available for plants this process has great interest for us. Organic substances are first converted to ammonia compound, these to nitrites, and lastly to nitrates, each stage being accomplished by a separate class of bacteria. By a study of the conditions favorable to the action of these bacteria considerable light has been thrown upon the value of tillage operations in promoting soil fertility. Good temperature and moisture conditions in the soil and a plentiful supply of air are the conditions upon which the action of bacteria mostly depends. Perhaps this could be taken as a partial explanation of the superior fertility of tropical countries. When we apply manure to our land we are virtually inoculating the soil with the bacteria which have been carrying on the process of decomposition in the manure, and we have here perhaps as great an object for the application of manure as the direct addition of food elements.

In 1886 Hellriegel discovered that a class of microbes created nodules or tubercles on the roots of Leguminous plants. He also discovered that these microbes living in symbiotic relations with the plant had the power of fixing free nitrogen of the air and of making it available for the use of the plant. * This process is

* 19th Century Magazine, 1898. pp. 994.

also carried on in three distinct stages. The microbe is at first a parasite living upon the tissues of the plant, then cells are formed in the tubercles, and finally these are absorbed by the plant. This class of organisms inhabit only leguminous plants, and Hellreigel found that in general different species were inhabited by organisms peculiar to themselves.

This method of obtaining nitrogen from the air suggests at once the reason why clover is such a powerful agent in enriching soils, and also gives us a method of furnishing nitrogen to our soils without the use of expensive fertilizers. In order to be sure, however, that our soil contains the germs required by any special crop we have recourse to several methods of inoculation. This inoculation, however, is only necessary in the first years of growth of a rare Legume, also many soils are naturally supplied with tubercle producing germs through the growth of wild Leguminosæ and through a wholesale distribution by the wind. Inoculation may be accomplished by the scattering of soil from a field where the particular crop has been grown for several years, and no cash outlay is necessary, or nitragin can be used. Nitragin is a concentrated germ fertilizer containing myriads of germs which are able to cause the growth of tubercles. Seeds can either be dipped in a water solution of the nitragin or it can be mixed with fine soil and sowed upon the field to be inoculated, owing, however, to the fact that extreme dryness or long exposure to bright sunlight destroys the germs, cloudy days or some other time than the middle of the day should be chosen, and the inoculating material should be promptly and thoroughly worked in. Various experiments have been tried at the different stations to determine the difference in yield of the different crops when inoculated and when not inoculated. * At Alabama an experiment with Hairy Vetch showed an increase of 995% in yield of an inoculated plat over one not inoculated. Field experiments conducted later† with Crimson Clover and Hairy Vetch give the following results:

* Bulletin 87, Alabama. † Bulletin 96, Alabama.

Field experiment with Crimson Clover:

	Yield per acre. Green, lbs.	Cured, lbs.
1 Inoculated	16746	4781
2 Not inoculated	1277	464
3 Inoculated	11333	3333
4 Not inoculated	3310	1059
Average inoculated	14039	4057
Average not inoculated	2293	761

Giving an average of 3296 lbs. more hay on the inoculated than on the plat not inoculated.

Similarly Hairy Vetch when inoculated gave a yield of 2540 lbs. of cured hay per acre, not inoculated 232 lbs., a gain of 2308 lbs. per acre.

These results show enormous differences in favor of the inoculated plots, but I think they are liable to lead us to give undue prominence to the value of these root tubercles. It seems to me that in the case of the Alabama experiments cited above, that the test was hardly fair in that the soil on which the experiment was conducted was very poor, and no nitrogen fertilizer being added the plants not inoculated were not able to get a sufficient supply and consequently the very weak growth. The experiments do show, however, how necessary a sufficient supply of nitrogen is to the production of large crops, and also that the root tubercles are capable of furnishing this supply.

From a consideration of the physical, chemical and biological effects of the Leguminous crops on the soil we find that we have here crops that when turned under are able to return to the soil nitrogen much in excess of that originally taken from it, crops that have transported mineral elements from the lower depths up to the surface, to say nothing of the beneficial effects upon the tilth of the soil obtained in turning under rank growth like that of clover, cow pea or alfalfa. Are not these facts sufficient to demand a place in every rotation for at least one leguminous crop, not mentioning the fact that if the crop is not desired for green manuring it can be taken from the soil and will furnish a crop of hay second to none in yield or feeding value?

GOOD ROADS.

BY LEON HAY, KANKAKEE, ILL., DELEGATE TO GOOD ROAD CONGRESS.

Road Building is an art. The problem of good roads is of paramount importance; it affects all classes of industry, yet owing to various causes it has been much neglected. True, our country is comparatively new, and can hardly be expected to have as perfect a road system as some European countries have; yet it is nevertheless a fact that for the lack of an organized system much time and money have been wasted. As an illustration, the County of Kankakee is about an average county in this respect, and from the data at hand there has been spent approximately over a million dollars on roads in the past forty years. Much of this could not have been used otherwise than it was at first, but possibly one-half of the amount could have been utilized in building permanent roads. The same is true of nearly every other county in the state. Had a judicious system been established twenty-five years ago, today Illinois would have thousands of miles of permanent roads. Strange that we, a people so progressive in almost everything else, should have neglected so important a matter, but what is past cannot now be helped. We can only profit by it in trying to do better in the future.

Almost the first thing that attracts the admiration of the American traveler in Europe, and especially in France, is the magnificent roads, where for miles and miles one can travel through the country on roads nearly as smooth, and to a grade as regular as a cement walk, with a row of trees neatly trimmed growing on each side. But before something similar is attempted in this country, as has occasionally been advocated, let us first look into their system of road building and see whether or not it would be practical here. Possibly it may cost more than we care to spend in that way, or perhaps it may be improved upon.

If only one or two practical points may be gained it will at least be so much gained. In 1898 while traveling there I found

the following systems under which all their roads were built and are maintained:

First, are the "*routes nationale*," before the republic known as "*routes imperiale*," built and maintained solely by the general government, according to fixed rules executed under the supervision of skilled road engineers. Next are the second class of roads known as "*routes departementale*" or what might come under the head of county roads as near as we could arrange it here. These roads are built and maintained solely by the "*departement*," by the labor system, but also under the supervision of the same engineers and overseers as are the National roads. And third, are the "*chemain vicinaux*" or what we might call township roads. These roads are the least important, also built and maintained by the labor system under the supervision of the same engineers and general overseers as are the two other classes.

On these three classes of roads are also constantly kept section hands under overseers who keep the roads in constant repair, *a plan which would certainly be a wise one to adopt on all kinds of roads in this country.*

Upon inquiry as to how much poll tax a man had to work on the roads there annually, I found that all able-bodied men, between the ages of 18 and 60, had to either work or pay for three days of labor upon the roads regardless of occupation, rank or position, unless in the military service, and of personal road tax as follows: Two dollars and forty cents for each horse owned over three years of age, and the same for a mule or yoke of oxen, and other things in proportion, which is vastly more than here. It is seen from this that the much abused labor system we have here, if properly managed, can after all be of great help in the building of roads. But the greatest lesson that can be learned from this is that France has only been able to get such magnificent roads through an organized national system, and until we have something corresponding to it, adapted to our wants, it will be of little use to expect the best results. We already have the Office of Road Inquiry under the United States Department of Agriculture doing grand and good work in the way of distributing road information. Its circular No. 17 on the Origin and Work of the Darlington Road League, shows what a com-

munity can do in the way of road improvement when all are willing to help. This circular has been the means of causing many a locality to organize and follow the good example laid down by the Darlington people in the way of road improvement, and until something better can be had it is probably the best method of road improvement. The only drawback is that occasionally the lack of experience will prevent the best possible use of the material at hand to be made.

Its Bulletin No. 12 on wide tires is very important. The curse of our hard and earth roads is narrow tires. In most European countries the width of tires is fixed by law according to the load each kind of vehicle can carry. Every vehicle is thus a road builder instead of a road destroyer. Bulletin No. 17, on Road Building in the United States, contains many valuable suggestions. Bulletin No. 8, on Earth Roads, Their Construction and Repair, ought to be in the hands of every road builder in the United States, as earth roads are bound to constitute the bulk of our roads for a long time to come. It is surprising to see what little care is exercised in their management, while with proper attention the muddy periods can be greatly reduced. In fact no man ought to be allowed to be a road officer or road builder until he had passed an examination and proven that he is competent to make the best possible use of whatever material he has on hand.

These, and a host of other publications that ought to be in the hands of every person interested in better roads, can be had free by applying to the Bureau of Road Inquiry at Washington, D. C.

I thus dwell upon the importance of this bureau because different localities require different methods of road making. It is not the aim of this article to lay down rules, but rather to help those interested in finding out what can be best adopted to their respective localities, and if possible to unite the efforts in establishing a national system somewhat on the plan of those of Europe. We already have the office of road inquiry. Its officers are the best posted men on roads in the United States, why could not this then be made the head of a national system? Then to work in harmony with it, but subordinate to it, let each state in

the Union appoint a State Board of Road Officers, consisting of three or five of the most competent men on road building in each state, from different parts of the state. Letting this board, with the aid of the head bureau, plan out what will be best for the roads of each state. Then let every other road officer in the state follow the instructions in road building laid down by this board. The plan is not to spend any more for officers than is now spent. It would be less, as it would do away with part of the minor officers. Three commissioners and four to eight overseers in each township is more than is necessary. Three competent men would be better and cheaper than nearly a dozen, mostly incompetent, in each township.

It is encouraging that something will be accomplished before long. A change is coming on gradually for the best, thanks to the League of American Wheelmen. On October 8, 1898, the National Road Parliament was held at the Omaha Exposition, where plans were formulated, and are already beginning to show results. At the National Farmers Congress, which has just closed its annual session at Fort Worth, Texas, a report was made from which I quote: "The farmers, who have so long looked with doubt and misgivings upon the good work of the L. A. W., are beginning to understand that this work is in their own interest, and that by working in harmony with the L. A. W. they can bring about the construction of durable highways without being obliged to bear all the expense, as they have so long supposed they would have to do. The Higbie-Armstrong law, by which state aid has been introduced in New York, provides for a division of the cost of road construction among the state, county and the local township. Many a town availing themselves of its advantages will secure an amount of money from outside sources equal to four or five times that which they raise themselves, most of these funds coming from the cities, where the tax levied to raise it is but a single cent per thousand dollars of assessed valuation."

Ever since the L. A. W. was organized in 1880, it has been working for better roads, but never before have its efforts been endorsed by a farmer organization. The Farmers National Congress consists of about 450 delegates, representing nearly

every state. It is the strongest agricultural body in the United States, and is a thoroughly representative body of wide-awake, up-to-date, although conservative, farmers, and was declared by Wm. H. Hatch, for many years Chairman of the House Committee on Agriculture, to have more influence with Congress than all other agricultural bodies combined. Its endorsement of state aid to roads and the L. A. W. work will have much weight with legislatures and farmers generally. It makes the turning point in the good road work of the L. A. W. and opens the way to united action between the members and the farmers of the United States. The book which the league is now circulating, entitled "Must the Farmer Pay for Good Roads," and expounding the state aid system, will do much to help this work.

In New York farmers own only one-fourteenth of the property of the state. Every farmer has been making roads for thirteen other men to travel on, and he is getting tired of doing it. He is now about to stop it, and he finds other people owning the rest of the property ready to bear their share of the expense of improving country roads. The only drawback is that the farmers themselves have been afraid to let any change be made in the road laws of the country, for they have imagined that the people of the cities design to impose heavier burdens on them instead of being ready to help them to carry existing ones. It was natural for them to think that such philanthropy was not wholly disinterested, but as it became daily more evident that all classes will reap the advantages resulting from improving the highways, that the ultimate burden will not be increased, and that all are ready to share it, the movement will acquire an impetus that will insure its future success.

It is said that the L. A. W. is going to try to have enacted in Illinois a law involving the principles described above. We who know these facts will be greatly responsible for the passing of this law. Can we not each take a little time to urge our legislators to vote in its favor? Are we going to do like the man who received one talent, go and bury it, or are we like the others, to go and put what we have on interest? As long as everybody will only tell everybody else what to do we never will see any change. It is only actual work that will bring good roads.

KINDS OF CULTIVATION FOR CORN.

By A. D. Shamel, Class of 1898.

The experiments with different kinds of cultivation conducted at the experiment station this season were a continuation of those begun last year, but on a more extensive plan, including some new treatments and a greater number of repetitions. The field upon which the cultivations were tested was fifty rods long by two rods wide, lying north and south. The south end was about eight feet higher than the north end, the north half being very level. The soil was a black prairie loam, the south half of the field containing more or less sand and gravel. From east to west the soil was of very even character. The field was sowed to oats in 1897, raising a fair crop of oats, the straw lodging on the north half of the field. The land had been cultivated for seven years, but the soil was in good condition for another crop. The ground was plowed April 26 and 27 with a three-horse breaking plow, about six inches deep, after which it was immediately harrowed. On May 20 the field was disced, harrowed and planted. The Burr's White variety of corn was planted with a drill, dropping a kernel about every five and one-half inches. The rows were three feet eight inches apart. The ground was in good condition when planted and nearly every kernel germinated. After the corn was about four inches high it was thinned to exactly 36 stalks for every two rods, making an average of one stalk to every eleven inches. The whole field was divided into twenty-two equal divisions so that each division contained five rows of thirty-six stalks each. A space of three feet eight inches was left between each division, in which space the corn was cut out. On the eleventh division all of the corn was removed, the object being to determine the effect of the different treatments upon the moisture of the soil where no corn was grown.

Five rows were used for each kind of treatment, the yield to be taken from the three inside rows. One treatment was mulched on June 17 with June grass (the mulch being tucked in around each individual stalk). After settling the mulch was compact, covering the ground to a depth of about four inches. (Upon one of the plats of corn weeds were allowed to grow undisturbed by cultivation of any kind after the corn was planted). The kinds of treatments in the order they come in the fields were: ordinary or about three inches deep, two inches deep, four inches deep, six inches deep, six inches deep large shovels, no cultivation, weeds, mulched, ordinary repeated, deep early and shallow late, shallow early and deep late, deep early and shallow late smoothed with a harrow after each cultivation, shallow cultivation with a Tower cultivator, Tower cultivator ridged later in the season, ridged, and harrowed.

The implement used for cultivating the different depths was a Sears cultivator, with attachments having three shovels on a side. The shovels were medium sized, about four inches wide at the top and about six inches in length. By means of levers the shovels could be set to run at a certain depth, and this depth could be varied by moving the levers up and down, so that an even depth of cultivation could be maintained throughout each treatment. For the Tower cultivation Tower attachments were used on the Sears cultivator. They consisted of two blades set flat on the ground so as to scrape off the weeds, leaving a shallow surface mulch. For the second ordinary cultivation, next the mulched, attachments were used having four small shovels set on each side. On the ridged a disc cultivator was used having three discs on each side, which could be set at such an angle as to throw the dirt up in any sized ridge desired. For the large shovel cultivations the New Departure tongueless cultivator was used, with two large shovels on a side. In the no cultivation the weeds were removed with a sharp hoe, the soil being stirred as little as possible in order that the least possible effect from cultivation would be produced. The harrow used in the harrowed was a small harrow with iron frame. The teeth were set in the frame so that they could be adjusted at any angle desired. The harrow was set to run between two

rows and was kept from injuring the corn by handles held by the person driving. This harrow was also used for smoothing the deep early and shallow late.

During the season samples were taken every week to determine the percentage of moisture in the soil under the different treatments. To secure representative samples they were taken between the third and fourth rows in each treatment and at about the same relative position between the rows in each kind of cultivation. The samples were taken with a 1¾-inch wood auger having a handle 44 inches long. The first sample was taken from one to nine inches, the second from nine to eighteen inches, and the third from eighteen to twenty-seven inches. Each sample was placed in a Mason jar, tightly sealed to prevent evaporation, and taken to the laboratory, where the samples were weighed into pans and placed in a drying oven and dried at a temperature 212° F. for forty-three hours, after which they were weighed again, the loss representing the amount of moisture in the sample. The percentage of moisture was then calculated from this data. In this way an accurate record of the relative amounts of moisture in the different treatments was kept during the entire growing season.

The plats were cultivated four times during the season. In the deep early and shallow late treatment the first cultivation was six inches deep, the second about four inches deep, the third about three inches deep, and the last cultivation about two inches deep. The shallow early and deep late was cultivated the first time two inches deep, the second time three inches deep, the third time about four inches deep, and the last time about six inches deep. The ridge treatment was ridged gradually higher during the season until at the time of the last cultivation the ridge was about nine inches high. The Tower cultivator was set to run about two inches deep and about six inches from the hill. The harrow ran about three inches deep and from five to six inches from the hill. It produced a fine loose mulch and left the soil fairly free from weeds. The harrowed treatment was gone over with a hoe once during the season in order to get the weeds out from between the stalks in the row. The deep cultivations thoroughly removed the weeds. The two-inch

cultivation with shovels did not remove the weeds as well as the harrow, and was hoed twice during the season. The three-inch, four-inch, six-inch cultivations, the ridged, and the mulch were very efficient in removing and preventing the growth of weeds. The shallow cultivations did not take out the weeds thoroughly, especially in the rows of corn. The deep cultivations left the soil ridged and badly torn up between the rows. The shallow cultivations left the ground level and in good condition. The mulched corn grew very slowly during the early part of the season on account of the excessive moisture, but during the dry weather it advanced very rapidly. The effect of the deep cultivations were marked during the entire season and the corn was much behind the shallow or no cultivations at the end of the season. On the weed plats the corn was stunted and did not develop or mature well. The cultivation with the large shovels removed the weeds and did not seem to be very injurious to the corn. However, the soil was left ridged at the time of the cultivations, the surface soil was turned over and so stirred that the surface dried out rapidly.

On July 14 the chinch bugs began to move from the oats on the east of the field into the corn. Immediate measures were taken to prevent the bugs from injuring the corn, and this was successfully done by means of coal tar. Two rows of corn next the oats were left for purposes of experiment, and the next two rows were cut out below the surface of the ground. The ground was then smoothed with a drag and afterwards thoroughly packed with a heavy roller. On this smooth surface the tar line was run the length of the field. The tar was run out of an ordinary three-gallon sprinkling pot with a spout fourteen inches long. A wooden plug was placed in the end of the spout, leaving a hole just large enough for a stream of tar about the size of a lead pencil to run out. The can was carried along as fast as a man could walk, the main point being to leave an unbroken line of tar. The line was renewed twice every day for fourteen days, after which the bugs did not move. The entire cost of protecting the field was eighteen and three quarter cents per acre, counting the cost of the tar at $5.00 per barrel and including all the cost of labor and utensils.

In order to determine the amount of injury to the roots of corn by cultivator shovels, experiments were conducted with root pruned corn, and observations made of the effects on the corn. The seed used in the experiments was the Burr's White variety, planted in hills three feet, eight inches apart each way. The rows were so arranged on the plats that one row was root pruned, and the next row was left without pruning in order to check results from the pruned. The plats were cultivated about three inches deep with small shovels. The implement used for pruning was a hoe-shaped blade, ten inches broad, very thin and with a long handle. On the blade was a guard so arranged that it could be set at any position on the blade so as to regulate the depth to which the blade would penetrate the soil. The corn was root-pruned on the different plats two, four and six inches deep respectively, six inches from the hill after every cultivation. Care was taken to disturb the soil as little as possible during the pruning process, and to cut off all the roots to the entire depth to which it was desired to prune. In harvesting the yield of the root-pruned rows were compared with the yield of the rows beside the root-pruned. The yields are given and the results discussed with the yields from kinds of cultivation.

The corn on the kinds of cultivations was shocked the second week in September and husked the second week in October. The three inside rows of each treatment were used for obtaining results, and the rows of each plat were tied in separate bundles and so tagged that they could be identified.

The yields were as follows:

KINDS OF CULTIVATION.

YIELDS OF CORN. BUSHELS PER ACRE.

Ordinary...90.06 bu. (3-in cult.)	6 in. deep.87.81 bu. (big shovels.)	Ordinary...91.46 bu. (3 in. deep small shovels.)	Tower....88.36 bu.
2 in. deep..89.06 bu.	No cult...93.14 bu.	Deep early, shallow late.88.57 bu.	Tower....90.67 bu. (later ridge.)
4 in. deep..89.52 bu.	Weeds....58.53 bu.	Shallow early, deep late.....88.88 bu.	Ridged...94.26 bu.
6 in. deep..84.75 bu.	Mulched..81.71 bu.	Deep early, shallow late.89.87 bu. (smoothed.)	Harrowed.91.42 bu.

STOVER, TONS PER ACRE.

Ordinary . . . 2.22 T. (3-in. cult.)	6 in. deep . . . 2.19 T. (big shovels.)	Ordinary . . . 2.58 T. (3 in deep, small shovels.)	Tower . . . . . . 2.54 T.
		Deep early, shallow late . . 2.54 T.	
2 in. deep . . . 2.31 T.	No cult. . . . . 2.57 T.		Tower . . . . . 2.61 T. (later ridged.)
		Shallow early, deep late . . 2.35 T.	
4 in. deep . . . 2.30 T.	Weeds . . . . . 2.05 T.		Ridged . . . . 2.47 T.
6 in. deep . . . 1.92 T.	Mulched . . . 2.31 T.	Deep early, shallow late . . 2.40 T. (smoothed.)	Harrowed . . 2.99 T.

AVERAGE PERCENTS OF MOISTURE FOR 1ST, 2D AND 3D DEPTHS.

	3 in. Deep.	2 in. Deep.	4 in. Deep.	6 in. Deep.	6 in. Deep, Big Shovels.	No Cult.	Weeds.	Mulched.	Ordinary, 3 in. Deep.	Deep Early, Shallow Late.	Shallow Early Deep Late.	Deep Early, Shallow Late, Smoothed.	Tower.	Tower, Later Ridge.	Ridged.	Harrowed.
1st Depth . . .	29.01	29.45	32.28	32.17	31.71	29.88	27.41	39.56	34.72	37.48	36.29	39.14	37.04	35.21	34.62	35.76
2d Depth . . .	32.28	32.26	34.53	36.29	35.80	32.25	30.85	38.38	35.86	36.81	36.00	36.63	34.63	34.22	33.36	33.41
3d Depth . . .	34.71	36.13	36.33	38.25	37.47	36.81	34.46	39.56	36.05	34.48	35.66	34.71	33.45	34.63	35.48	32.84
Average of all depths.	32.26	32.57	34.29	35.55	34.27	32.89	31.19	39.11	35.50	36.36	35.78	37.45	35.15	34.92	34.10	34.25

* ROOT PRUNED.

	Number of Ears.	Wt. Corn.	Wt. Stalks.
2 in. deep . .	270	144.50 lbs.	118.25 lbs.
4 in. deep . .	279	139.25 lbs.	90.50 lbs.
6 in. deep . .	253	107 lbs.	80.75 lbs.

† NOT ROOT PRUNED.

	Number of Ears.	Wt. Corn.	Wt. Stalks.
Average . . .	260	218.62 lbs.	177.50 lbs.

* Each weight given is the average weight of four rows.

† This yield is the average of twelve rows.

By a close study of the yields it is seen that the harrowed, ordinary, two-inch, no cultivation and ridged treatments gave the highest yields. The deep cultivations, weeds and mulched gave the lowest yields. The low yield in the case of the mulched was undoubtedly due in great part to the excessive rainfall during the season. The corn on the mulched was stunted early in the season by the excessive moisture around the young plants. It never fully recovered, and the yield was consequently low. The greatest *total amount* of moisture was found in the deep cultivations. The deep cultivations contained, on the whole, more moisture than any of the other treatments, with the exception of the mulched. But in studying the amounts of moisture in the different depths it was found that the shallow cultivations contained more moisture in the *first nine inches* than the deep cultivations. The amount of moisture in the subsoil of the deep cultivations is greater than in the subsoil of the shallow cultivations. In other words, deep cultivations tends to conserve moisture in the subsoil, while shallow cultivations tends to conserve moisture in the surface soil. As practically all of the roots of the corn supplying the plant with food are found in the first nine inches of soil, it follows that any cultivation which does not injure the roots, and which conserves moisture in the soil around the roots, is the best kind of cultivation. The shallow cultivation, which leaves a light, loose mulch, tends to conserve moisture in the first nine inches of soil.

In the root-pruned, the pruning process had a very injurious effect on the plant. It stunted its growth, reducing the yield of both corn and stover, almost in proportion to the depth of pruning. No doubt part of the reduction in yields of the deep cultivations was due to injury to the roots by the cultivator shovels. The large shovels on the New Departure did not seem to injure as many roots as the small, sharp shovels on the other cultivators, being set farther from the hill. The ridged corn, cultivated with the disc, was not injured by the discs, and the large yield was partly due to the absence of injury from root pruning. The discs threw up ridges along the rows of corn, and during the heavy rains of the early part of the season the excess of water ran off the field between the rows. The surface soil

was not torn up, turned over, and consequently the moisture percentage was high. The effect of injury to the roots was most apparent in the yields of stover. The yield was reduced proportionally as the depth of cultivation was increased, The harrowed, no cultivation, lower and ridged, all shallow cultivations, gave the highest yields of stover.

There was a difference between the kinds of shallow cultivation in their relation to the development of the plants and their effect on soil moisture. The cultivators with small shovels turned the surface soil over and allowed the moisture to rapidly evaporate. At the same time the sharp points and edges of the shovels injured the roots near the surface. The harrow did not turn the surface soil over, but stirred it, making a fine loose mulch without cutting any roots. An implement constructed on the principle of the harrow, which could be operated on a large scale, would be best under ordinary circumstances.

The results of this and last season's experiments would seem to indicate that shallow cultivation was preferable from the fact that it conserves the moisture for the use of the plant, avoids root pruning and leaves the soil level and in good condition for the next crop.

AN AGRICULTURAL SURVEY FOR ILLINOIS.

By J. E. Raymond, Class of 1899.

In tracing the development of agriculture from a primitive art to the undisputed place among the sciences that it holds today, the observer is immediately impressed with the important part that the natural sciences have taken in this development. This, however, is the only logical way in which the evolution spoken of could have taken place. Botany, geology, chemistry and physics had first to be developed before agriculture could be pursued from a truly scientific standpoint.

The establishment of the land-grant colleges, some thirty years ago, by virtue of the act introduced by the late Senator Justin S. Morrill, and the founding of the state experiment stations some years later, were the beginnings of agricultural education and scientific research specially relating to agriculture. These institutions have been of great value in promoting interest in scientific agriculture; but many of these have failed to receive the support from their states that they deserve. The education offered by the colleges has enabled young men who availed themselves of it to become better farmers and better citizens. The bulletins issued by the experiment stations relating to scientific research along the various branches of agriculture are for the most part eagerly received by the farmers, and accepted as guides to successful practice.

The director of the Illinois experiment station receives many questions from correspondents relating to various subjects, sometimes of general, and often of interest only to the party concerned. The questions are always answered in a courteous manner and as much information given as is available. At present our experiment station is receiving large numbers of soil samples, which are sent in by interested individuals for examination and analysis. Many questions are also received which pertain to newly introduced cultivated plants, such as cow peas or sugar

beets. In a state having as large an area as has ours, there is necessarily a great diversity of soil and of resources for plant growth, and no one station, wherever it may be located, can fully and satisfactorily serve the people of all parts of the state. The establishment of several stations or substations may at some time be possible, but for the present some less expensive plan should be provided. How then may more concrete information relative to our soil resources be collected and interest in scientific agriculture and agricultural education be stimulated?

Some years ago the state provided a considerable sum of money for a natural history survey of Illinois, which has been of great value in the scientific study of our native flora and fauna. Quite recently a state water survey has been established for the examination of the potable waters of the state. The work done by these and other surveys is valuable, and of great interest to all, but is not Illinois the greatest agricultural state in the Union? Is it not possible to obtain in a similar manner much concrete information relative to our soils and resources for the production of agricultural crops, which will be of great practical and scientific value to citizens?

If provision be made for an agricultural survey many questions will come up regarding the aims, scope and management of the project. Consequently great care must be taken, not only in the selection of the chief or director, but also in the choice of such a staff of assistants as may be necessary to accomplish the best results. The state of Tennessee has undertaken, through its experiment station, quite a comprehensive survey of the soils of that state, and is the first of any in the Union I believe, in making an organized agricultural survey. A preliminary report made by the chief of the Tennessee survey and a soil map, compiled from the data obtained, is at present about all the literature that we have on the subject. These would probably be of considerable value in planning a similar enterprise for our own state. For instance, we could well copy the idea of putting the work in the hands of the experiment station management, as it would be more economical than the appointment of a special commission, and all the work would surely be carried on in a scientific manner. The time consumed in securing the soil samples

and making other field observations, as well as the subsequent examinations made in the laboratories, would necessarily be very great in a state the size of Illinois. A considerable sum of money must also be at the command of the director, for the expenses would be far from light.

Now what results may we reasonably expect from such an enterprise? Will not this trustworthy information thus obtained be highly appreciated by all classes of our citizens interested in agriculture? The reports or bulletins in the hands of the farmer will enable him to settle many questions to his own satisfaction without the inconvenience of personally applying to the experiment station for the information. Moreover, such questions as are asked can be more intelligently answered by the station, for exact scientific data secured in the locality of the party interested will always be at hand. To the prospective settler the reports will be highly valuable, serving as authentic guides which will enable him to more readily acquaint himself with his new home and adopt himself to new practices, therefore reducing to a great extent the time necessary to obtain the requisite experience for the achievement of success. This literature in the hands of the student will doubtless prove more valuable for many reasons than any text book which could be secured for him by his instructors.

It is not necessary further to enumerate results. Is it not evident that Illinois should be among the first to organize the work of an agricultural survey? Should not the question be taken up and agitated at the meetings of agricultural organizations that the people may become more familiar with the idea? For to a class of people as farseeing as the farmers of Illinois a word of suggestion is all that is necessary to arouse them to action.

WOUNDS.

By D. McIntosh, V. S., Professor of Veterinary Science.

In the study of wounds it is necessary to understand the nature of the structure wounded. The external surface of the animal body is chiefly composed of two kinds of tissue, the highly organized and the low form. All the fleshy or muscular parts belong to the former; the tendons, ligaments and cartilage to the latter. What is meant by highly-organized tissue is where it is largely supplied with blood vessels, nerves and lymphatics, while the low order of tissue contains very few if any blood vessels, nerves and lymphatics, and is nourished by the vessels which ramify over their surface. When a muscle is wounded the first thing nature does is to pour out a liquid to repair the mischief done. This may take place by adhesion, or by a fine granular substance which develops and fills up the injured part; blood vessels shoot into it and it becomes flesh, and so it proceeds until the part is repaired. If no accident happens to it, either by the animal rubbing or biting it, or last, but not least, by the applying of irritant substances such as turpentines or strong liniments, which destroy the fine, delicate young tissue that nature is pouring out for repair, all that is needed to assist nature in the healing is to protect it from injury. First examine the wound to find the depth and direction and to see that there is no foreign substance in it, then remove all hair or dirt and wash it out carefully with water in which a little carbolic acid has been put, about a teaspoonful to the quart of water. If it is a superficial wound it is best cleaned by letting the water run over it, and if deep, use a syringe with gentle force. Washing with a sponge is too rough for the new tissue. If the wound is a clean cut, lengthwise on the muscle, stitching is of use. If the wound is ragged or cut crosswise, stitching is of no use, as the ragged parts have to slough off, and the movement of a muscle prevents

a cut from uniting and must heal by granulation. After a wounded muscle has been cleaned, wash as little as possible, as it will disturb the healing process. In the majority of flesh wounds, if they are not disturbed they will heal very rapidly. They will heal even if treated by strong liniments, but very likely there will be a blemish, which would not be if nature was not interfered with. There is an idea that most people have that they must use something to keep out the cold or heat, which is a mistake, and by doing this the strong medicines used do far more damage than cold or heat.

Wounds are divided into four kinds: Incised (clean cut), lacerated (torn), contused (bruised), and punctured wounds. I shall give the treatment of each kind separately. A clean-cut wound lengthwise on the muscle usually heals by what is called first intention. First examine the wound as to its depth and direction and to see that there is no foreign substance in it, next stop bleeding by applying cold or hot water to it. If a large vessel has been cut it requires to be tied. Then mix one teaspoonful of carbolic acid in a quart of water and let a little of this run over the cut surface. Then bring the edges of the wound together either by pins, silk thread, or cat-gut steeped in the above lotion. Pins are the best, as they remain in longest without sloughing. The pin should be inserted one-eighth of an inch from the edge, and when both lips have been transfixed in this way, a thread or small cord carried around both edges of the pin and made to describe the figure eight will hold the wound close. The pins should be put in about three-quarters of an inch apart. If the thread or cat-gut is used the needle should be passed in about a quarter of an inch from the edge of the wound and brought out at the other side about the same distance, then the two ends of the thread are tied and another stitch about three-quarters of an inch apart, and so on until the wound is closed; apply a little carbolic lotion once a day to the part, but be careful not to disturb the wound. If the wound is across the muscle and is of an inch or more in depth, stitching is of no benefit, as we cannot prevent the cut ends from moving below the stitches and union will not take place, but if it is superficial it may be stitched as before described. If the part should swell and get

hot it will be necessary to take out some of the pins or stitches in order to get it cleaned. Foment with hot or cold water. Then inject some of the carbolic lotion; do this several times daily. After the inflammation has been subdued the wound will heal by granulation.

Lacerated (torn) wounds require to be examined as the others, cold or hot water used to stop bleeding, and cleaned by letting water run over them. There is no benefit to be derived from sewing up a wound of this kind, as the ragged parts have to slough off in the form of matter, and if it is penned up by the wound being stitched it cannot escape; the parts swell, and the stitches give way, leaving the edges more ragged than before, so it is best in all cases of torn wounds not to stitch them. If after a time the wound should assume an unhealthy or spongy appearance, use acetate of lead, half an ounce; sulphate of zinc, half an ounce; acid carbolic, one dram; and water, one quart. Clean the wound with water, then apply a little of this lotion twice a day.

Punctured wounds are the most dangerous of all because they are liable to contain foreign substances, such as hair, pieces of wood, etc., and are likely to inflame, ending in mortification and perhaps the death of the animal. Wounds of this kind require to be examined with great care. Probe the part to find the depth and direction of the wound, also to ascertain if there is any foreign substance at the bottom of it, and if so, it must be removed. It is advisable to make the opening larger, also to have it depending, so that any fluid matter that may form in it will run out. It is often very difficult and even dangerous to do this, besides causing extra suffering to the animal. And I find that a depending opening in the majority of cases is unnecessary if the wound is properly treated. Instead of enlarging the wound, clean it as well as possible, then dip a piece of soft muslin in a solution of carbolic acid, three drams; water, four ounces; press this down to the bottom of the wound with a probe, let it remain in for a few hours, then draw it out and put in a fresh one; do this three times a day for a few days. This will act as an antiseptic, destroying germ life and preventing mortification. In a few days matter will form and all danger is

passed. Clean it out twice a day with warm water and inject a little of the carbolic lotion used for incised wounds.

Contused wounds. These are usually caused by pressure, kicks or bruises. In the majority of cases the skin is not broken, and if the part is bathed with acetate of lead, half an ounce; water, one quart, several times a day to keep down inflammation, it will likely give no trouble, but sometimes effusion will collect from the effects of the injury, and the part will swell up and will be soft and puffy to the touch. In this case it will be necessary to open it and allow the fluid to escape. Then inject a little of the following twice a day: Zinc chloride, two drams; water, one quart. If it leaves a thickening, rub on biniodide of mercury, one dram; lard, one and a half ounces, every second week. For old, unhealthy sores, such as are made by a constant rubbing and will not heal, remove the cause and apply a little terchloride of antimony with a feather. In three days a scab will come off, and if it looks soft and spongy apply a little more of the antimony every third day until the part becomes healthy. Then use zinc oxide, one ounce; lard, two ounces; rub on a little once daily.

We now come to speak of wounds of the low order of tissue, which is found in the legs from a little above the knees and hock joints to the feet; here we have the tendons, ligaments, cartilage and their connective tissue covered by skin. These structures when injured require great care so that they will heal without leaving a lump or blemish. Usually a low form of inflammation sets in and we have a discharge of a yellow; sticky substance which exudes from the wounded tendon, also secretions from the connective tissues. The surrounding parts swell and become hard. The center of the wound also fills up and in time becomes higher than the surrounding skin, and when the wound heals it leaves at this part what is called a bunch without any hair, which is a very unsightly blemish. On account of so many barbed-wire fences nowadays there are a great many horses and colts blemished about the legs and feet. When an animal meets with an injury to any part of the leg from the knee downward, put it in a place where it can be kept quiet and prevent it from hurting the part. Bathe it every half hour for

the first twenty-four hours with a lotion made with acetate of lead, half an ounce; sulphate of zinc, half an ounce; tincture of arnica, two ounces; water, one quart. This will keep down inflammation and prevent the outpouring of the secretions above mentioned. After twenty-four hours bathe it well three times daily with the above lotion until it heals. If it should fill up higher than the skin, then apply a little bichloride of mercury with a smooth piece of stick. Never use more at a time than would lie on a dime, as there is danger if large quantities are used, of enough becoming absorbed to poison the animal. Use it every third day until it is lower than the surrounding skin, then apply the healing lotion as before. By keeping the center lower than the surrounding parts the skin will grow over it, leaving no bunch or blemish. If there should be a thickening of the surrounding skin, which I have sometimes seen after it is healed, rub on a little of the following: Biniodide of mercury, two drams; lard, two ounces; mix. Let it remain on twenty-four hours, then wash off and apply a little lard. Repeat every second week until the enlargement disappears. In any of the above named injuries, if the animal is fevered or its legs swell from standing, give the adult horse half an ounce of nitrate of potassium three times a day in its drinking water or a bran mash for a few days, and half this quantity for a yearling. If the animal is in an unthrifty condition give the following: Sulphate of iron, four ounces; nux vomica, two ounces; nitrate of potassium, four ounces; mix, and divide into twenty-four doses, one to be given twice a day in mash, and half the quantity for a yearling colt.

THE SAN JOSE SCALE, AND REMEDIES FOR ITS CONTROL.

BY R. W. BRAUCHER, CLASS OF 1897.

Probably no single species of insect has aroused so much interest over as wide an area and in so short a space of time as the San José scale in recent years. Other insects have doubtless excited a greater interest for a time over small areas. For example, take the destructive locust of the western plains, which in certain seasons sweep the country as by wildfire, and the Gipsy moth (*Porthetria dispar*) that has become established in thirty-three towns in Massachusetts, covering an area of 220 square miles in the immediate vicinity of Boston. This insect became such a scourge in Medford, Malden, and some of the other suburbs of Boston, from the immense numbers of caterpillars that covered the sides of the houses, fences, sidewalks and streets, and stripped the leaves from all kinds of trees and plants, that the State took the matter in charge and determined to exterminate the pest. It undertook the work in 1890, and up to the close of 1897 had appropriated $775,000 for this work; and it is probable that the work will cost over $1,000,000 before its completion.

Dr. L. O. Howard says of the work: "It is true that a large amount of money has been expended, and it is also true that much more money must be expended before extermination can be accomplished; but it is undoubtedly safe to say that the money which has been and will be spent by the State in this work is but a drop in the bucket to the loss which would have been occasioned by the insect had it been allowed to spread unchecked."

The Cottony cushion scale (*Icerya purchasi*) in California for a time threatened the complete destruction of the citrus-fruit interests of that great horticultural State, and was largely responsible for the discovery and introduction of hydrocyanic

acid gas as an insecticide. It has since been brought under control and reduced to insignificance by the introduction from Australia of two predaceous insects, *Vedalia cardinalis* and *Novius koebelei.*

The San José scale has been the direct cause of the passage of laws for the suppression and control of injurious insects in sixteen different states, and several other states are now contemplating the passage of such laws. The last Congress had a bill under consideration, but failed to pass it. Ontario and British Columbia have enacted such laws, and the Dominion government has had a law under advisement. The San José scale was responsible for the exclusion of American fruits and plants from the German markets by an edict promulgated by the German government in February, 1898.

The writer has been frequently asked whether or not the San José scale is really as bad as it is claimed to be. I can best answer this by giving the experience of those who have worked with it and a few figures of the losses it has occasioned, letting the reader judge for himself whether or not the fears that have been expressed in some quarters are exaggerated.

Dr. L O. Howard, of the Department of Agriculture at Washington, has this opinion to offer: "We are therefore justified in the assertion that no more serious menace to the deciduous fruit interests of this country has ever been known." Professor W. G. Johnson, state entomologist of Maryland, says: "In my opinion . . . . . the San José scale is the most pernicious orchard pest established in the United States."

Mr. George K. McGaw, one of the owners of a three-hundred-acre peach orchard in Maryland, which orchard was destroyed by this pest, says: "I cannot imagine a more deadly destructive enemy to peach trees than this insect. The 28.000 fine, healthy peach trees in our orchard two years ago, at present evidence the penalty we have paid to its introduction into this state." He further says: "It is our intention, and we are now (December, 1897) at work on its execution, to destroy the entire peach orchard, consisting of something over 28,000 trees." In a conversation with Professor Johnson he said that $25,000 cash would not compensate him for the loss he had sustained from

the attacks of this ravenous pest in his orchard, to say nothing of the loss of the use of the 300 acres of land for nearly eight years.

In summing up the condition in Maryland, Professor Johnson says: "The 95 infested orchards contain 157,165 bearing trees, of which 58,620 were infested, and 50,343 of these have been killed from the attacks of the scale during the past four or five years, and have been dug up and burned. This leaves still standing 8,277 infested trees in the midst of 106,822 bearing trees in their prime. Aside from the above, 21,577 nursery trees have been destroyed, making a total of 71,920. The actual loss in dollars, of course, can not be determined; but figuring the cash value on a taxable basis, the owners of these trees have lost $68,897, to say nothing of the loss of land, labor, crops, etc. The losses to individuals vary from a few dollars up to the enormous sum of $25,000. In several instances the orchards have been completely swept out of existence in a few years, and the cause was not ascertained until the work of the deadly enemy was completed."

While Maryland has probably been the heaviest loser from the San José scale of any of the eastern states, others have sustained very heavy losses, and numerous examples could be found of the destructive work of this pernicious pest when once introduced into a fruit region; but the above ought to suffice to convince the most skeptical.

In Illinois the San José scale has not become as firmly established or as widely scattered as it has in most of the eastern states, and if the question is taken hold of with the same energy and determination that Massachusetts has displayed in taking hold of the Gipsy moth problem, there is little doubt but that it can be quickly brought under control and finally exterminated.

Of the 25 localities in which the San José scale has been found within the State of Illinois up to the present time, in most of them it is still confined to the original orchard, and in some cases to the original trees on which it was brought into the state.

In a few of the places where it has been established for some

time it has done considerable damage; as, for example, at Sparta, where it has spread to different parts of an area of about twenty-five square miles. Here a good-sized peach orchard has been wiped out of existence and several others are in nearly as bad condition. At Richview, Mt. Carmel, Auburn and several other places there are orchards that are in very bad shape.

The twenty-five places in which the scale has been found are distributed over the State as follows: Monroe Center, in Ogle county; Dundee, in Kane county; Tremont, in Tazewell county; Manito, in Mason county; Quincy and Paloma, in Adams county; New City and Auburn, in Sangamon county; Assumption, in Christian county; Vermilion and a farm southwest of Sandford, Ind., in Edgar county; Tower Hill and Herrick, in Shelby county; Ernst and Walnut Prairie, in Clark county; Collinsville and Alhambra, in Madison county; Mascoutah, in St. Clair county; Sparta, in Randolph county; West Salem and Browns, in Edwards county; Mt. Carmel and a farm west of that place, in Wabash county, and Villa Ridge, in Pulaski county.

The last state legislature placed three thousand dollars at the disposal of Professor S. A. Forbes for the purpose of ascertaining to what extent the San José scale has become established within the state, and to take what measures were thought advisable toward the suppression and extermination of the pest. By the use of this appropriation he has been able to locate the above twenty-five infested localities, and to carry on insecticidal operations in twenty-one of them. The result has been that in seven of them the scale has been exterminated, or so nearly exterminated, that it was impossible to find any living specimens after a careful examination of all the trees treated. In nine of the places the number of living scales, after a season's growth, was so small that it was only after diligent search that living specimens could be found. In the remaining five places that were treated the number of living scales has been so greatly reduced that it will take one or two seasons for them to become as bad as they were before being treated.

Illinois has been fortunate in the presence of the San José scale being detected and the infested places located before it had become thoroughly established, and in having a state entomolo-

gist able to cope with so formidable an enemy, and capable of handling the difficult and complicated problem of exterminating the pest, now that it has been found.

In exterminating this insect, the surest way, and probably the best in the end, is to grub out and burn everything on which the scale is found. This seems to be a great sacrifice to get rid of so small an insect, but it is the method followed in most of the places in which the work of extermination seems to have been successful. In a few of the places where the trees were not badly affected, spraying with whale-oil soap solution seems to have succeeded in exterminating the pest. In most of the places where quite badly affected trees were sprayed with this solution, over ninety-nine per cent. of the scales were killed, but there were still enough left that had escaped the soap to reinfest the orchard if left to themselves.

The method followed in treating the trees with the whale-oil soap solution was about as follows: The trees to be sprayed were vigorously trimmed back and thinned out, so as to reduce the surface to be covered as much as possible without injuring the trees. All the rough bark that could afford shelter to the insects and keep the soap from reaching every part of the tree was scraped off of the trunk and larger limbs. The soil was removed from around the base of the tree to expose any scales that might have found lodgment on the bark below the surface of the ground. Everything removed from the tree on which scales might maintain themselves for a time was carefully gathered up and burned.

The soap solution was prepared by dissolving two pounds of whale-oil soap in every gallon of water by vigorous boiling. After the last of the soap was dissolved, and while the solution was still boiling hot, it was placed in a barrel to which a good spray pump was attached, and at once sprayed on the trees before it had a chance to cool. There is so much soap in the solution that when it becomes cool it solidifies, and consequently it is necessary to do the spraying while the solution is hot.

The greatest care must be taken to thoroughly coat every part of the bark in every part of the tree. The success of the treatment consists in reaching every part of the bark upon which

a scale can be found, thus reaching every insect. If this is not done, though only a few scales escape, it is only a question of a few years until the trees will be thoroughly infested again. The greatest objection to this remedy is the practical impossibility of spraying an orchard without missing some part of some of the trees.

A number of other remedies have been recommended by different writers. Among these are pure kerosene, kerosene and water in a mechanical mixture as applied by the recently introduced kerosene sprayers, kerosene emulsion, and fumigating with hydrocyanic acid gas.

As regards the use of pure kerosene as an insecticide there is a great difference of opinion. As I have had no experience with its use, I can probably do no better than to quote from some of those who have. Professor W. B. Alwood of the Virginia Experiment Station says: "The foregoing matter and unpublished matter in the records of the work now in progress show that pure kerosene can be safely used upon all fruit trees in the dormant season, and with proper precautions during the growing seasons also. The chief point to be observed in its application is the proper atomization of the kerosene.... The skill and judgment necessary to insure safety in this work are not such as to preclude the use of kerosene by fruit growers, hence, in the light of the above and other unpublished experiments, I recommend it as a summer treatment for the San José scale. I believe it to be the treatment *par excellence*, as in every case where I have used it on this scale it has destroyed it with great certainty."

Prof. John B. Smith of New Jersey says: "The essential points to be regarded in the application of kerosene are the finest possible spray, the completest and thinnest possible coating over the entire surface, and weather conditions favoring rapid evaporation. The trees themselves should be dry. Any departure from these suggestions may cause injury, for I wish it distinctly understood that kerosene improperly used is fatal to plant life."

Mr. Marlatt of the Department of Agriculture says: "That spraying with pure oil will often kill trees cannot be doubted,

even when applied in the dormant condition in winter, as demonstrated by experiments on a number of apple and peach trees two or three seasons ago."

Professor Webster of Ohio conducted a series of experiments applying the oil with a fine spray and with a brush. Out of twenty-three peach, apple, pear, plum and cherry trees treated, fourteen were killed or seriously injured. Of six peach trees treated, four were killed and two badly injured. Of the results he says: "It seems that kerosene cannot be safely used on peach trees, or on plum trees of tender varieties; but that, if applied lightly with a brush to the more hardy plums, pears and apples, it can be used safely, if the trees are cut back to trunks and bases of limbs."

Mr. Morrill of Benton Harbor, Michigan, tells of an instance where 30,000 peach trees were killed by being sprayed with pure kerosene although very fine nozzles were used.

Judging from the above the use of pure kerosene on trees is an extremely hazardous operation, and should be done with extreme care or not at all. The same can be said of the kerosene and water and kerosene emulsion when strong enough to be effective against the San José scale.

Hydrocyanic acid gas as a remedy for scale insects has been used for a number of years in California with very good results. It is a surer remedy and much more satisfactory than spraying, but the first cost of the outfit is so great that it is doubtful whether it will be very extensively used in this state or in the east except for disinfecting nursery stock. It is now the only remedy that is extensively used for this purpose. In using this remedy it is necessary to enclose the trees in an air-tight tent while being subjected to the action of the gas. in order to work to the best advantage it is necessary to have from ten to fifteen tents, so that by the time the last one is adjusted the first one is ready to be moved. The tents cost from fifteen to forty dollars each according to size. While this is the most desirable and successful remedy thus far tested, it can not always be relied on to completely exterminate the San José scale by one treatment, especially when the trees are very badly affected.

DRINKING WATER.

By A. W. Palmer, Sc. D., Professor of Chemistry.

In all ages civilized man has been at great pains to secure adequate supplies of wholesome water. Even in the earliest times of the world's history, cities grew and populations centered where pure water was to be had in abundance, or pure water was brought from distant sources by means of stupendous works, the remains of which stand today, lasting monuments to the energy, the skill, and the wisdom of the races of antiquity. The aqueducts which brought to the people of Ancient Rome a greater daily supply per capita than is furnished to any modern city, bear witness to the importance ascribed by the ancients to the possession of water in plenty and purity.

Probably no modern city has expended so much treasure and labor for the purpose of providing a system of water supply as did Rome, and the fact that now, after two thousand years, some of the ancient aqueducts are still in service, attests at once to the foresight and the seriousness of the projectors and the genuineness of their work of construction. In all parts of the world, wherever ruins of ancient civilizations are found, there abound evidences of hydraulic works which we of the present day may well regard with respect. The ancients further seem to have been thoroughly awake to the dangers involved in the use of polluted water, and to have recognized the most serious source of contamination, namely, the wastes of habitation. They were acquainted moreover with the purifying processes of filtration, precipitation by means of alum, and they knew the efficacy of boiling, but it remained for modern science to discover the various substances which are normal constituents of natural waters and those which are the disease-bearing constituents of pollution, and to devise ways and means to detect their presence,

estimate their quantities and determine their nature as affecting health or conveying disease. Although there remains much still to be learned concerning the action of water, pure and polluted, upon the animal economy, and the precise nature and influence of their characteristic ingredients is not yet thoroughly understood, yet the propositions that abundance of wholesome drinking water is a most important factor for the preservation of health, and that the drinking of impure water constitutes a most potent means of developing and spreading disease, are well established facts. These facts are so well established indeed that a recent lawsuit has resulted in the payment of substantial damages to the family of a man who died of typhoid fever caused by use of impure water supplied by a city waterworks company. Although today all intelligent human beings recognize the desirability of a supply of pure water, and most of our citizens are aware of the danger which is involved in the use of contaminated water, yet much ignorance prevails concerning what constitutes impure water, and respecting the conditions which bring about contamination.

Pure water in the stricter sense of the term as used by the chemist does not occur in nature, for the reason that water is an almost universal solvent, and that, as it exists in nature, it is almost invariably in contact with something which it can dissolve. The character and the quantities of the foreign substances contained determine the condition of the water as being safe and wholesome for use as drink, or impure and likely to cause derangement of the system. Chemically pure water is generally flat and insipid and is no more wholesome for healthy human beings than is a natural water which is charged with moderate quantities of certain mineral constituents.

Freshly fallen rain, collected after the atmosphere and the collecting surface have been thoroughly washed free of the various impurities which are ordinarily present, doubtless constitutes the purest water which nature affords, but as customarily gathered and preserved, cistern water is usually far from pure since it contains the washings of both the atmosphere and roof, and these being largely organic may enter into putrefactive change and become a source of danger. In general, water taken from

lakes, from streams, or from the ground, when these are in their original or natural condition, is perfectly unobjectionable and wholesome, but with increasing population and longer occupancy of the ground the conditions change.

In the case of surface waters—*i. e.*, lakes and streams—visual knowledge of their contamination by sewage, accentuated by widespread knowledge of almost innumerable instances of destructive epidemics which have resulted directly from the use of such waters in their polluted condition, arouses public attention to the need of improvement.

As is well known, the recurrence of epidemics of cholera, typhoid fever, and other zymotic diseases, have almost invariably been prevented wherever the causes have been abolished, either by diverting the sewage from access to the source of water supply, or, where this is impracticable, by proper filtration of the polluted water. The importance attached to the attainment of such improvements by the people directly interested is sufficiently evidenced by the enormous expense which the citizens of Chicago have assumed in providing the great drainage canal for the purpose of avoiding the necessity of drinking the sewage of the city diluted with lake water.

With respect to ground waters, the public is not in general so well informed, otherwise the use of privy vaults, barnyards, cesspools, and shallow wells, in close proximity to each other, would be no longer tolerated. That such things are still permitted to exist side by side in our towns, villages, and country places, is doubtless due to certain popular misconceptions touching the functions and powers of the soil. Earth is commonly regarded as an excellent purifier, and justly so; but the purifying power of the soil is not unlimited, and the earth itself may become contaminated by that which it seems to render innocuous, but which in many instances it merely conceals from our senses.

Filtration of polluted water, in order that it be effective, must be in some degree intermittent; that is, the filtering material must be frequently renewed, either by replacement or by exposure to the air. This principle, the basis of successful practice in management of filtration plants for the purification

of polluted water supplies, and likewise the basis of modern methods of sewage disposal by irrigation, is not generally apprehended by those who depend for their water supply upon shallow wells, although it applies with equal force to the process of soil-filtration upon which they place reliance for the removal of all objectionable matters from the liquids which find their way through the soil to the wells. Because the water from such wells is in general clear, sparkling, cool, and of agreeable taste, it is commonly supposed that it is wholesome, and the continued use of such water for drink during many years is frequently cited as argument in their favor. It must be remembered that sewage from healthy sources may, in a diluted state, be drank with impunity; but while very few people would *choose* to do this. yet multitudes do so unwittingly in their use of well water.

The greatest danger lies in the fact that the sewage may at any time receive dejecta from diseased beings, and the well consequently become the means of distributing the disease.

Although matters which are offensive to the senses are commonly either mechanically removed or are oxidized, or are otherwise rendered innocuous during the passage of sewage-laden waters through the soil, yet the danger, instead of being lessened, is frequently increased by reason of the false security which this apparent purification engenders.

Germs in general, but more particularly those germs which are the specific cause of disease, are much less readily affected, and are known to pass for considerable distances through soil strata and to remain in the palatable but deadly infusion from which most of the other organic substances have been removed.

Contamination of the water supply may occur in the most unsuspected ways. Frequently, water-bearing strata which supply wells or springs so situated as to be free of any possible local contamination, outcrop at a distance, but at places where the surface is polluted. Cases are known of wells which in this way are fed by the rains which fall in a city several miles away, so that while the immediate environment of the wells is favorable, yet the water yielded is unwholesome by reason of its containing the washings of the town, which, sinking into the

ground at the outcrop in the city, may be drawn from the country well for use as drink.

Contrary to former belief, even the water drawn from deep driven wells may contain numerous germs, as has been recently shown by the Massachusetts State Board of Health.

Numerous instances of the dissemination of disease to the extent of producing great loss of life by epidemics, by the use of well or spring waters which were highly prized because of pleasant appearance and taste, are to be found recorded in sanitary literature. Contrary to popular belief, diseases arising from, or distributed by, impurities in the water supply are much more prevalent in the smaller towns and the country districts than in the large cities, as has been shown especially by the study of typhoid fever in New York and Massachusetts, the two states in which the investigations of these subjects have been most thorough-going and complete. This is because the larger towns and cities get their supply from a considerable and general source which is under constant observation of those whose business it is to furnish pure water, while in smaller places the ordinary house well is the source of supply.

The importance of these facts will appear when we remember that more than half the citizens of Illinois get their water supply from a half million wells, most of which are shallow and so situated that the larger proportion of them receive drainage from refuse animal matters. The far too common practice of making a well within the barnyard or but a short distance from privy vault or cesspool can not be too severely condemned, particularly in case it be dug well, for the ordinary dug well constitutes a pit for the reception of drainage from a considerable area of the surrounding surface. Boring a hole or driving a pipe from the bottom of the dug well deeper into the earth may result in securing a greater supply of water, but it does not prevent the access of drainage from above, and hence does not avoid the danger. The fact that the well passes through clay strata which are supposed to be impervious does not lighten the danger, because the drainage will flow along the surface of the clay and thus reach the well after coming from considerable distances.

Except in the few localities where the conditions of soil

strata and surface and the methods of disposition of refuse matters are unusually favorable, the dug well which is not tightly cemented from the surface down to the strata which underlie considerable thicknesses of clay, must be regarded as a constant menace to health. The deep driven well is generally to be depended upon for pure water, but often the driven well receives it supply from strata which are somewhere pierced or reached by open wells or other excavations, so that the drainage from the surface reaches the supplying strata and of course reaches that which would otherwise be an excellent well.

If a human life has a money value, then the labor and cost of so disposing of animal and other refuse matters by means of dry earth closets or proper drains and sewers, and of getting water exclusively from such sources as can be shown to be perfectly wholesome, will be repaid many times over, while the reduction in doctors' bills and funeral expenses will work hardship only to the physicians and undertakers. The agriculturist has, however, another interest to be served, for the domestic animals appear to be just as susceptible to the influences of impure water as are human beings. Many of the specific diseases of animals may be communicated through polluted water. Just as typhoid fever, cholera, diphtheria, etc., are conveyed and rendered epidemic among our citizens by use of contaminated water, so, among the domesticated animals glanders, foot and mouth disease, cattle plague,, anthrax and even perhaps pleuro-pneumonia are spread. The so-called hog cholera is undoubtedly a filth disease. Furthermore the ova of various parasites, as the tape and other worm, are easily communicated by use of water which receives barnyard drainage. Even when no specific disease is caused yet the use of impure water lowers the tone of the system and renders it more susceptible to disease. The flesh and milk of animals is often tainted from the same cause. The more study that is given to these matters makes it more and more apparent that the health and life of all animals, both human and others, is largely affected by the nature of the water which is drank, and it becomes evident that the best means of insuring good health and vigor is to provide an abundant supply of pure water.

POINTS ON PORK.

By Fred H. Rankin, Secretary Illinois Live Stock Breeders' Association, Athens, Ill.

America is preëminently the home of the hog. He is a logical deduction from Indian corn—a sort of an automatic machine for reducing the bulk in corn and enhancing its value; a machine that feeds itself, converting ten bushels of corn into one hundred pounds of pork.

Truly, the hog is the product of nature's most economical thought. There is no part that can not be utilized. His flesh, fat, bristles, blood and bones are all turned to account. He is the staff of life, the arch enemy of famine, the poor man's best friend. In adult pighood he is omniverous and self-reliant and expeditionary; breeds faster, grows faster and keeps cheaper than any other domestic animal, not barring the hen or dairy cow.

Nowhere else as in this broad prairie land of Central Illinois does corn grow in such opulence. Where this cereal most abounds there the pig flourishes and waxes fat. While he sometimes squeals, but like Jeshurun of old, who waxed fat, he never "kicks." A region with a monopoly of corn and hog can have all other good things added unto it, even to an Agricultural Building and equipments, where the basic principles of all great agriculture will be taught to a thousand boys and girls each year, around and from which radiating afar will be culture and learning—comfort, health and wealth of ideas as well as dollars. A source from which shall come strong men and women for all vocations, making of our farm homes not Paradise but an inviting approach. In the bringing about of which we must all pay tribute to the mightily directed swine industry. This claim will seem none too strong if you will consider what this country would be were the hog and all that his product has contributed to our material prosperity stricken from the land.

The hog is a true cosmopolite—a citizen of the world, and comes about as near representing and possessing the fat of the land as any one we know of. In all civilized lands he is equally at home at the tables of the high-born lords and ladies and in the rudest cabins of the lowly. He camped with our boys in blue at Chickamauga; was their intimate friend in the rifle pits of Santiago, and was it not breakfast bacon which refreshed and inspired Admiral Dewey and his marines to complete the notable victory in Manila harbor a few months since? If this claim seems "*far-fetched*," remember it is a long way from Manila here.

The hog is more closely identified with the masses than any other variety of our live stock. Let the price of horses or cattle be increased, and many are benefited, no doubt; but increase the price of hogs and you replenish the purse of the masses. Quite poor, indeed, is he who can not own a pig, and thrice blessed is this humble creature by the great mass of our people who live so close to nature's heart. Many a grocer's bill is paid, many a bank account started, that would not have been without the assistance of his porcine highness. The small amount of capital required, his quick response to feed and his rapid convertibility into money makes him essentially the poor man's friend. Our modern pig is a most valuable adjunct to a well regulated farm—a sort of condensing factory, or manufacturer of hams, bacon, lard, oils, hair brushes, tooth brushes, headcheese, glue, buttons, soaps, souse, sausage and—satisfaction. In fact, every part of the hog is utilized except the squeal, and rumor has it Professor Hopkins is planning to analyze that. Yes, even to the ladies our hog will remain "a thing of beauty and joy forever," so long as there are taxes to pay, a mortgage to lift, a house to build, a piano, a surrey, a new dress to buy, or a boy or girl to be sent to the University of Illinois.

Have you not seen the thrifty old sow, with her family, peregrinating in the fields of a June morning, nipping clover blossoms, gathering sausage by the wayside? And when she chanced to make a raid on the hens and chickens you thought that Solomon in all his glory was not a raid (arrayed) like one of these.

So far as to what a hog eats is concerned, he simply knows what he likes better than even Professor Davenport can tell him, and given half a chance he will go directly to it. As a case in point, he cannot be induced at any time to eat so much meal or sweet milk that he will not then, even at considerable discomfort to himself, travel quite a distance to hold a post mortem on a deceased mule or cow.

The United States produces annually from forty to fifty million head of hogs. In the year of 1892 we had fifty-two million head of hogs, following which there was a steady decrease in numbers, showing only thirty-nine million seven hundred thousand swine on January 1, 1898, which is the lowest number listed during the past eighteen years,—the number having decreased not only relatively, but absolutely. Had swine increased in the same ratio as population we should have had more than sixty million hogs in January, 1898, instead of a little less than forty million, as shown by the Department of Agriculture. Why is this relative decrease of 33⅓%? The explanation is easy when it is remembered that early in the eighties an investigation developed the fact that the packers had discovered that a mixture of fat of swine, beef stearine and cotton-seed oil made a hogless lard, which would pass muster with all but experts. The changes wrought in values and style of pork products by the constantly increasing use of cotton-seed oil as a substitute for the fat of swine is a phase of the swine industry that the progressive stockman must take into consideration in his breeding and feeding operations. The "heavy thick backs" or "lard hogs," that a few years ago were in active demand at every packing point, are no longer quoted and are often hard to sell. It is a notable fact that while the number of swine constituting the world's commercial supply continuously dwindles, our exports of lard, with much greater domestic requirements, have steadily increased during the years when our swine herds have been declining relatively in numbers. The increase of lard exports have exceeded 50%, while exports of such pork products as are not susceptible of adulteration with cotton-seed oil have been diminished about 6%, despite the enormous increase of consumers of pork in the importing countries.

An average crop of cotton is accompanied by an output of some 900,000,000 pounds of cotton-seed oil, of which much goes abroad and returns to our shores as "olive oil," considerable quantities are used in canning fish, but the major part of the entire product—probably but little less than one-half is converted into "compound lard," while small portions are honestly quoted as "cottolene" and "cotto-suet."

As the price of lard and other pork products has fallen, it may be noted that so in the same ratio has fallen the price of corn. Evidently there has existed a much closer relationship between the value of corn and the price of lard than the much exploited one between the value of a bushel of wheat and the price of an ounce of silver.

The conversion of a by-product of the cotton field into eatable fat, and a valuable feeding stuff for cattle, has resulted in absorbing the demand for the product of almost ten million acres of Indian corn, and has reduced the corn-growers' revenue by probably one-fourth and the swine herds of the United States by fully a third.

The loss to our swine interest from disease in 1897 was 12% the total number of hogs, estimated to be worth about one hundred million dollars. Numerically considered, Iowa is the first hog state in the Union, having 3,625,000 head. Missouri, Texas and Ohio rank next in the order named, while our own state stands fifth in this husbandry, with 2,150,000 hogs. Six years ago Illinois ranked second.

An interesting phase of this subject has been the growth of our export trade in hog products. The total value of hog product exported in 1897 was over eighty-three million dollars. Comparing this data as given by the Bureau of Statistics for the same year, shows that if we count all of the exported horses and mules, all of the cattle and fresh and salted beef products, all of the sheep and mutton and all the butter and dairy products sent to alleviate the hunger and wants of the people in foreign lands, they foot up to a total less than we realize from our surplus hogs, and their products which we send abroad.

The principal reason that our pork product is discriminated against in some other countries lies in the fact that it sells

cheaper and is better than their own productions. The prime trouble with our friends across the Atlantic is that America's exports exceed her imports, that she is growing rich somewhat at the expense of other nations. Unless we are mistaken this disparity of trade between the old world and the new is the prime reason for the prejudice against the American pork product, and has more to do with raising the cry of trichinosis than the existence of the parasites themselves.

In the production of profitable pork good stock must be the foundation. The signs of the times point to two things very plainly, the honesty and integrity of the breeder, and the individuality of the hog, will receive greater attention. From now on the pig will be more of a factor than the pedigree.

In live stock husbandry the work of improvement is never done. The ideal of to-day may be attained to-morrow, but not that of to-morrow. The way thoughtful stockmen are seeking to do to-morrow's work is by keeping up the standard of individual excellence to the highest notch, seeking it in the best blood to be found, but not accepting even the best blood unless the individual excellence that should accompany good breeding be coupled therewith.

Select the breed that is best adapted to your needs and taste, and then stay within the breed. Sometimes a single out-cross gives satisfactory results, but we do not advocate it. Avoid in-breeding or too close line-breeding. Do not attach undue importance to particular strains that happen to be fashionable, or to fancy points of color of hair, etc., provided that you do not get outside the color of the breed; but give special regard to vigor of constitution, robustness, capacity for digestion and assimilation. Feed intelligently, shelter well, and any man can grow first-class stock whether he calls himself a breeder or not. Some of our most observant breeders are coming to think that in some of our breeds of swine the process of refining the bone and lightening the frame work has been carried very near to the danger line, and the time has come to emphatically call a halt in that direction. Too little attention is being given to securing sturdy, straight limbs and strong, upright feet, whereby the pig is able to stand squarely and steadily on its feet. Among the objectionable fea-

tures to be guarded against are the long, slender, pipe-stem style of legs, ending in slim, uncertain ankles and weak feet, together with a failure to carry the meat of the ham full and well down toward the hock.

The strong arched back, the well sprung ribs, the full heart girth, the broad shoulders, the deep ham, the strong underpinning and short, shapely foot—these are among the more vital points to be observed in the building of a good and thoroughly useful herd of hogs. An attempt at a combination of as many of these good points as possible in the shaping of a farm herd is a good thing.

The good brood sow should be large and long and deep bodied, neat head and broad between the eyes, strong flinty bone, and large heart girth indicative of well developed vital organs and consequently a vigorous constitution. Select sows from the progeny of matured dams that are kind mothers, good sucklers, prolific and of quiet disposition. The sow that possesses these qualities and is a good breeder should be a fixture in your herd. You do not discard the cow from your dairy that has proven herself valuable; act likewise in reference to the good brood sow.

The male should be a full-blood and a first-class individual. Do not let a few dollars deter you from buying a good one. He should be, if any different, more compact in his make-up than the female, with a very short head, broad between the eyes, a very short, full neck, a short, well-coupled back, strong and full loin, with a well sprung rib, well filled down in flank, a deep full ham, legs short, straight and wide apart, standing upon short, strong feet. Top and bottom lines nearly on a parallel, except the back may be slightly arched,

The Scotch have a saying, "The eye of the master fattens his stock," and this is true in swine feeding, for even pig feeds must be mixed with—or rather by—brains. There is one fundamental principle in the economy of feeding that should never be overlooked. No animal can change the elements contained in the food consumed, into other elements that may be needed by its system. No breed of hogs can convert a strictly fattening food into juicy, lean meat. If you feed an excess of fat-formers the animal cannot change a part of these into bone-builders and

muscle-makers. Do not stint the feed of your breeding stock to avoid fat, but choose such foods as are rich in flesh formers, bone and muscle and nerve material, and use sparingly starchy foods such as have a tendency to produce too much fat. There is a great difference between flesh and fat. It is vain to attempt to make bricks without straw, that is, to develop a muscular animal without feeding muscle-making food. It is the easiest thing in the world to produce fat, where fat-making elements of food are cheap and abundant, the *frame* being first provided.

The difficult problem with the stockman, whether on the farm or in the breeding establishment, is to provide *frames*, ready for the finishing. As an aid to this end the clover plant by its intelligent use furnishes, in its cheapest form, the material essential to the most perfect development of form and frame; it is nearly a perfect ration and should be the standby of the farmer. Clover is the corner-stone of American feeding. While Indian corn is the most easily produced and convenient single ration of hog feed we have, all things considered, yet the victims of it solid, in the porcine family, like the victims of it liquified, in the human family, are each year numbered by the tens of thousands. A variety of feeds insures better health and better growth for the porker, and a fatter pocketbook, better health, a better suit and a clearer conscience to the owner.

Do not try to raise hogs unless you like them. They will respond quickly to kind treatment. No domestic animal on the farm in Illinois requires closer attention than the hog, and no industry will pay you for your time as well as swine rearing and the pork making business in its common-place, every day workings. When conducted with a reasonable amount of fair, common-sense, and systematically staid by, one year with another, this industry will do well by its proprietor. Too often the poor despised hog has a poor chance to do for his owner all he is capable and willing to do. In fact, some people seem to have regarded the hog as the cause of the prodigal son's aberrations. But the writer will venture the suggestion, that very good hearted but very uneconomical boy kept on getting down from bad to worse *financially*, until he commenced to feed hogs, and then his salvation began.

BLIGHT OF APPLE AND PEAR TREES.

By T. J. Burrill, Ph. D., Professor of Botany
and Horticulture.

The term blight as applied to diseases of trees is very often used to designate widely different things, due to greatly differing agencies. Still the well-known disease of apple and pear trees chiefly characterized by the death of young, leaf-bearing branches and especially occurring in June and July, merits pre-eminently the name, and in fact receives it everywhere from those having most to do with these trees. It is usually supposed the effect is suddenly produced. The twigs or branches may appear one day healthy, well clothed with green foliage, and the next day the adhering leaves are black and dead. Closer inspection, however, shows that the seat of the trouble is in the bark, and that starting from a given point the malady slowly spreads so that after several days the limb is encircled by the death-dealing disease. When this finally occurs, the leaves above the affected parts do suddenly die whether or not they themselves are invaded by the active agents of the destructive process. They (the leaves) die in many cases just as they would do if the shoot were cut, though it is also true that the leaves are often involved in the fermentive activities which kills the shoot. Sometimes only the succulent tips of the new growth are destroyed, but in other cases the disease gradually spreads downward in the bark to the larger limbs, or through the latter to the trunk. It is far more common that the upper, younger portions of the tree or branch first succumb and that the older portions are subsequently infected by a slow dissemination downward, in the bark of the destroying organisms. But the latter may gain entrance to the tissues primarily of the trunk or larger branches through wounds or punctures of the outer, protecting layer of bark. Since such wounds are more liable to be made in the forks of branches, where the growth of the parts throws the

outer bark into rough fold, blight more often starts in these portions than elsewhere in the old tissues. So too blight is much more liable to occur in trees making large, succulent growth than in others of the same variety of slower development. When unpruned pear trees attain an age above fifteen years and are not unduly stimulated by fertilizers or by cultivation, there is usually little tendency to blight compared with the great liability of younger, more thrifty growing trees to the attack of the destroyer.

There is, however, much difference in varieties, apparently outside of conditions. Probably no kinds either of apple, or of pear, or of quince are absolutely blight proof. But a number of varieties usually escape. The Seckel pear is rarely injured, and its seedling, the Tyson, seems to be still further exempt. So far as known the Lincoln has shown no tendency to blight. Many others are somewhat resistant, though too great claims are often made for special kinds. Among apples the Russian varieties are much subject to the disease, and the Siberian crabs often blight worse than do pear trees. Our own native crabs do not escape, though they are types of ruggedness and hardiness. These latter are especially subject to attack when in flower. The disease often starts in the flowers, not only of crabs, but of any of the kinds subject to it. Sometimes nothing but the flowers are killed; at other times the disease so started follows down the twigs and branches.

The disease seems to belong especially to America. It is not known in Europe, at least in Western Europe. It seems never to have been reported from England, France, Germany, Italy, etc., but trees brought from these countries are as susceptible as are those produced with us. There appears to be some difference in climate or other conditions causing this peculiarity, instead of any difference in the trees themselves. The disease does occur in Australia.

Previous to 1880 nothing was really known as to the cause of the disease. Horticultural literature indeed teemed with discussions and elaborated opinions. The most diverse views were held, and what we now know to be the most absurd suggestions were made often by those accounted authorities in such matters.

At the date mentioned no plant disease had been proved to be due to bacteria. No one had apparently surmised that plants were subject to "disease germs," though by that time it was well known that some of the worst animal diseases were due to these minute creatures. The first published results of microscopic examinations of blighting tissues, showing the presence of bacteria, may be found in the Eighth Report of the Board of Trustees of the Illinois Industrial University (now University of Illinois) page 199: "The sap of the newly blighted limbs, especially in the young cells between the wood and bark, swarms with minute living particles, visible only with high powers of the microscope....The motion of these particles is a sort of an uneasy vibration, as if attached by a short thread and were endeavoring to escape. They are found in greatest numbers where the inner bark shows by discoloration the recent progress of the disease, but in some cases could be traced two or three inches below the discolored portions. Not uncommonly a thick, slimy fluid escapes from small holes in the bark and sometimes in quantities sufficient to run down the limb several inches. This is almost wholly made up of these oscillating corpuscles, and when fresh presents an amazing sight under high power of the microscope. * * No indications are yet observed as to the origin of the....vibrating particles. When this is determined something definite, and it may be very important, will be accomplished."

This was written under date of September 13, 1876, and is the very first matter in print in any language concerning bacteria and disease in plants. The name "bacteria" was not used in this communication, neither were the minute organisms, so well described, recognized as bacteria at the time. This was afterwards done, and on December 11, 1878 (see Transactions Illinois State Horticultural Society, Vol. 12, page 80) a similar account of the things found in the affected tissues was given, this time with statement that the minute organisms were bacteria. Some inoculation experiments had also helped prove the fact that the active agents in the disease process were none other than these microscopic parasites. Further experiments in 1879 and especially in 1880 confirmed the results, and definite publication was made (Trustees Report, 1880, page 62 and

elsewhere) in such manner as to settle the matter and at the same time to establish the fact, then otherwise unknown, that bacteria are disease agents in plants as well as in animals. Since that time this disease and many other plant diseases due to bacteria have been much studied, and decidedly valuable information has been ascertained. The special kind producing blight has been named *Bacillus amylovorus* (Burrill.)

The cause of blight is, we may be assured, thoroughly known. We may not know many things connected with the disease--why some varieties are more susceptible than others, why it is much more prevalent one year than another, etc.—but we can now string such information as we get upon one line, keep all so that it may have a common and definite bearing, and have it available for explanation and utilization sometime.

In the meantime something can be said about prevention. The first thing to do is to select kinds least liable to blight. Progress has been made and there is much room for hope that kinds will be found practically proof against the disease. Next it seems quite conclusive that pear trees blight less when the ground is left in grass than when thorough cultivation is practiced. After these trees become of bearing age on rich soil cultivation is not necessary to produce good fruit. Pruning must be sparingly practiced. When growth unsatisfactory cultivation or fertilization can be resorted to. With the ordinary orchard apple less danger, except to young twigs, is to be anticipated, and cultivation is so greatly needed otherwise that the risk of increased blight must be hazarded. Finally the progress of the disease in an affected limb can be checked by a prompt removal of the diseased portion. As the spread of the contagion in the tissues is really slow—an inch or so a day at most—careful examination of trees once a week and the removal of all infected parts will usually serve to prevent serious injury. This should especially be attended to during the last half of June and during July in our climate. A careful examination should also be made in late autumn, since the organisms live over winter in the bark of affected parts. So far there is nothing known which can be applied in a spray as a preventive or remedy.

GRAPE GROWING.

By J. C. Blair, Assistant Professor of Horticulture.

HISTORY OF THE AMERICAN GRAPE.

Grapes have been a recorded product of the American soil ever since the days of the Norse navigators, who touched our northeastern coast in the year 1000. Some 630 years later, the New Englanders commented on the vines that "but for the fire at the spring of the yeare would so over spreade the land, that one should not be able to passe for them." But coming from England, these colonists were little accustomed to seeing grapes growing in profusion, and were still less familiar with wine making, therefore the native vines were little heeded among the New England colonies, while even in 1565 the Spaniards of Florida were making wine of the wild grapes. Professor Bailey quotes the interesting fact that "as early as 1769, the French settlers at Kaskaskia, in Southern Illinois, made 110 hogsheads of wine from wild grapes." When the attention of the American settlers was finally directed to grape growing as an industry, they unwisely looked to foreign vineyards for their stock instead of cultivating the material nearest at hand. It took failure after failure and many years of bitter discouragement before the first native grape, called the Cape, opened up the broad field of American viticulture.

But this grape was of such inferior quality that it soon ceased to be cultivated, and for the first great native grape, the Catawba, John Adlum, of the District of Columbia, is to be thanked. He also in 1823 wrote the first treatise on native grape culture. In 1825 Nicholas Longworth planted Catawba cuttings near Cincinnati, thus bringing the cultivated native grape west of the Alleghanies for the first time. Some twenty-five years later, having acquired great wealth as a result of his venture as a commercial viticulturist, he prophesied that the grape would be worth millions of dollars to the United States.

He earned for himself the worthy title of "Father of American Grape Culture." Other varieties of native grapes were meanwhile gaining favor and cultivation in different parts of the United States, and American viticulture was fairly on its triumphant way.

IMPORTANCE AND EXTENT OF CULTIVATION.

The grape having been successfully cultivated in America for scarcely more than forty years, is nevertheless assuming great commercial importance in nearly every state in the union. The acreage in the United States according to the census reports of 1890 was 401,261 acres. Of these about 200,000 acres were devoted to our native American grapes and are to be found east of the Rockies, while the remainder—the wine grapes of California—are of foreign origin. The product of New York state alone, for 1890 was 60,687 tons of table grapes, and 2,528,250 gallons of wine. This enormous product was very closely followed by each of the following states: Illinois, Ohio and Missouri. In 1894 it was estimated that there were 58,000 acres of grapes in western New York alone, while Illinois was not far behind, since the census returns of 1890 show that her total acreage in 1, 2 and 3 year old vines was 604, or second in extent, as against 1,497 acres in New York at the same time.

METHODS OF PROPAGATION.

The grape vine may be propagated by seeds, layering, cuttings and grafting, but it is grown from seed only when new varieties are desired, since they do not come true. Layering, for the amateur, is probably the easiest and most satisfactory process of multiplication, requiring little or no skill, while nursery men who are trained for their business usually use cuttings. The former process is accomplished by covering a portion of the old canes, preferably not more than a year old, with two or three inches of loose soil of such a character that it will retain the soil moisture. This should be done in the early spring, and if strong, vigorous vines are desired it is best to leave not more than five or six buds on each cane. These will produce as many plants as there are buds, and will be ready for lifting and separating in August or September. These new

vines should then be heeled-in by covering with earth, thus affording protection for the winter and keeping them in readiness for planting in the spring. This is a process which can often be taken advantage of where vacancies in the vineyard rows are to be filled.

SOIL AND LOCATION.

Light, sandy or gravelly soils make good vineyard lands; yet if there is quite a proportion of clay accompanied by good drainage, it is preferable. Rich soils are to be avoided, since they produce a strong growth of canes and leaves with fruit of inferior quality.

If the land is at all adapted to the growing of the grape the only fertilizer needed can be most profitably supplied in the form of soil cultivation. Stable manure and commercial fertilizers should rarely, if ever, be used in the vineyard. Cultivation improves the physical condition of the soil by increasing its water-holding capacity, and if done frequently will prevent evaporation. Cultivate during the growing season about once a week; stopping shortly before the period of ripening, and considerably sooner if too luxuriant a growth is induced thereby. The too common practice of allowing grapes to shift for themselves where the canes are hardly visible above a rank growth of grass and weeds is to be discouraged. Instead of giving them a neglected area about the buildings let them occupy a rolling piece of land or a northern or western slope where they may be more free and open. Plant them in rows about ten feet apart and about ten feet apart in the rows, the latter distance varying with the variety, giving the individuals an area of about 100 square feet, thus lessening the chances of injury from disease. When planting the young vines care should be exercised in removing any superfluous roots, spreading those that remain fan-shaped, thus giving every opportunity for the earth to come in close contact with them. Avoid leaving a tangled mass of roots bunched together in one place, making air spaces which subsequently fill up with water, eventually killing the root system. The top of the vine should be cut back to about two buds.

PRUNING AND TRAINING.

The first year after planting the young vines should make

a considerable growth from these two or three buds which have been left. Before growth is resumed the next spring, say during February or March, this neglected growth should be entirely removed excepting two or three buds on each of two canes. This severe pruning is for the purpose of giving the root system of the young plant ample opportunity to be thoroughly established. At the end of the second year pruning is resumed, leaving two of the most vigorous shoots, or better still, about 2½ feet of each, to be trained in opposite directions on a horizontal wire placed about thirty inches from the ground. These will send out flower and fruit-bearing shoots which are to be trained up to a second horizontal wire about thirty inches above the first. The third year's growth following the operation just described should be carefully watched, else the vines may overbear, thus weakening them and rendering them less capable of producing the normal crops expected of them in later years. To be more explicit, should each of these shoots produce three or more flower clusters, all but one on each shoot should be removed. The length of growth made by canes during any season will depend on the variety, soil and other conditions, but on the average each will bear two or three clusters of grapes near its base. From one to six of the canes are usually left. The variety, size of vine, age, kind of training and the soil must decide the number of clusters which a vine should carry. Thirty clusters, or 12 to 15 pounds of No. 1 fruit is an average crop for a Concord vine. During the winter prior to the fourth year's crop the pruning consists of cutting back each of these canes to within two buds, one of which, and usually the weaker, is removed by rubbing off in the spring after the growth has started. This pruning is an annual operation which must be done with care and precision during the lifetime of the plant. One will readily see, however, that these vertical shoots on which the fruit is being borne are yearly raised to the height determined by the previous year's pruning. It will therefore perhaps be necessary occasionally to renew these horizontal arms on the lower wire by taking out new ones frow the old stub near the ground.

In the above description of the pruning of the vine, reference has been made to one system of training, which may be called

the Horizontal Arm Spur System. It is a good illustration of the upright type, of which the Chautauqua or Brocton and High Renewal are also examples. The former type of training was first clearly presented by Andrew S. Fuller in 1864. Aside from the upright systems there are the drooping and horizontal, giving in all three general systems of training. Of the drooping systems, the Kniffin is an example, named in honor of William Kniffin, a Hudson valley grape grower, who in 1854 accidentally stumbled on the method which now bears his name. It is a four-cane system, two running in opposite directions on each of the wires, and from which the shoots grow and are allowed to droop freely. This is a system which is gaining friends all over the country, as it has many merits, such as lessening labor and expense in tying. The Umbrelia system, the six-cane Kniffin, the Caywood, Overhead or Arbor Kniffin and Renewal Kniffin are also other drooping systems.

Of the horizontal types of grape training there are very few examples. The best known are Post training and Arbor training. Of the former there are various methods, but all possess the advantage of allowing cultivation both ways and saving of expense in trellising. The faults, however, are so marked as to have made them almost entirely supplanted by other methods. For example, the thick heads of foliage furnish excellent breeding places for rot and mildew, as well as prevent due ripening.

The first system described is one which may be modified to suit the grower, as, for example, placing a third wire, thus giving a greater plane for the development of the vertical shoots. It may be profitably supplanted in many regions by some form of the Kniffin or other drooping system, in which case the top wire should not be less than six feet from the ground and the method of pruning governed accordingly.

In all the foregoing it is well to note that there is a marked difference between the pruning and the training of the grape vine. Pruning is a yearly operation, and in practice there is but one general rule to be observed—namely, cutting back the wood of the previous year's growth to within two or three buds, from which new shoots may spring the following year, and on which the fruit will be borne. It should also be said here that

the terms applied to the different parts of the vine have significant meaning, which should be clearly understood. The "shoot" is the term applied to the growing, flowering and fruiting wood of the season. The "cane" is the matured shoot, and is the part (excepting two buds) to be removed before the next year's growth commences. The "spur" is that portion of the cane bearing the two buds from which the new shoots are to spring, while the "arm" is the older cane bearing the spurs, and is in turn borne on the trunk.

The whole practice of pruning and training is of the most vital importance in successful grape growing, and indeed many grape growers little appreciate its value. Without this careful pruning the vine will be overtaxed with energy expended in cane-bearing which should go into fruit production, the fruit, therefore, being of inferior size and quality. The canes should be so distributed as to admit light and a free circulation of air, both indispensible to a healthy and properly matured grape. If rot or mildew should attack the vines and fruit when so trained and pruned, they can be easily controlled by spraying.

SPRAYING.

The commercial grower, as well as the farmer who may desire grapes of a high quality, or often even grapes of any quality at all, must give due attention to the operation of spraying. It is an annual occurrence, and is for the purpose of combating fungous diseases especially, although sometimes for insects. Since the insects are not often serious enemies of the vine, mention need not be made of them, devoting such space as remains to a brief discussion of some fungous enemies.

One of the most serious diseases, and one which sometimes causes entire loss of the crop, is anthracnose, a disease which attacks the green stem, leaves and fruit. Its appearance upon the stems is first indicated by blackish spots sunken in center, enlarging as the disease advances until sometimes the entire cane is encircled. Its appearance on the fruit is made in a similar way.

Treatment—This is one of the most difficult diseases to combat. Bordeaux mixture is of little or no avail. Before the buds swell make an application of sulphate of iron and sulphuric acid

solution, prepared by dissolving 110 pounds of sulphate of iron by pouring upon it one quart of sulphuric acid, adding immediately 26 gallons of hot water. This caustic solution can not be applied with a spray pump, but is applied with a swab or sponge.

Black rot, ripe rot, and powdery mildew are diseases which can be controlled by the Bordeaux mixture and ammoniacal copper carbonate. Make the first application of Bordeaux mixture as soon as the first leaves are fully expanded, repeating this after the fruit has set, and again at intervals of two to three weeks, until fruit is about three-fourths grown, when the ammoniacal carbonate of copper should be used.

The "rattles," or "shelling," as it is sometimes called, while not a fungous disease, may be an indirect result of this, and insects or improper nutrition. It is a serious menace to successful grape growing in some localities, and can only be overcome by proper fertilizing of soil in addition to spraying for prevention of fungous diseases.

VARIETIES.

While the question of varieties is a local consideration and must be answered by each grower for himself, after collecting what information he can from those neighbors who have had experience and from other sources, still there may be a few varieties suggested for Central Illinois, based on the experience gained at the State Experiment Station after the testing of nearly two hundred different varieties.

The three best grapes for general culture are, in order: Concord (black), Lindley (red), Delaware (red).

Grapes recommended for general planting:

BLACK.	RED.	AMBER.	WHITE.
Concord,	Woodruff's Red,	Perkins.	Moore's Diamond,
Worden,	Brighton,		Niagara,
Herbert,	Lindley,		Green Mountain.
Moore's Early,	Massasoit,		
Barry.	Brilliant,		
	Delaware.		

IMPROVEMENT OF ILLINOIS BEEF.

BY E. T. ROBBINS, CLASS OF 1900.

Much of the beef bred in Illinois is very inferior in quality. The herds of really good cattle devoted to the production of beef for the market are far less numerous than are the herds of scrubs. This is true, not so much because of those who are in the business on a really commercial basis, and who are studying the demands of the market, as on account of the great majority of farmers whose surplus cattle are sold to local buyers. Our native stock, to be sure, has some blood of the best breeds in it, but "blood" does not necessarily make quality. Animals, even with excellent pedigrees, may themselves be poor specimens. Then again, the indiscriminate mixing of breeds which has happened to a large extent in the production of our native cattle tends, if either way, rather to undesirable reversions than to the preservation of the latest acquired perfection of characters. A great many of the small herds, especially of farmers who are not making beef production a specialty, have been selected, where quality is at all considered, with a leaning rather to the production of milk than of beef, the surplus animals being sold for veal or matured and put on the market for prices much below the best. Most of these cattle are profitable neither for milk nor beef. The last census shows the butter production per cow in the United States to be 130 lbs. per annum, while practical dairymen say that a cow which makes 200 lbs. is just paying expenses.* This low yield of butter is due principally to those cattle which are kept without any systematic attention to their real quality. There is a little blood of the pronounced dairy breeds, *e. g.*, Jersey and Holstein, in most of the herds in some sections, of the State, and the animals which have it are unfit for profitable

*H. B. Gurler, The Illinois Agriculturist, 1898, p. 55.

marketing for beef. Not only are they poor for beef themselves, but they are drawbacks to the whole class in which they are handled. Men who make a business of buying cattle for feeding, will not pay the top price for a bunch with some Jersey or Holstein grades in it, and usually the farmer is unwilling to cull the lot, so they all go at a sacrifice. When they are fattened and put on the market there is the same discrimination against them, not from prejudice against their breeding, but on account of their poor carcasses.

Feeding range steers has of late years been a large industry in this State, and many carloads of western bred steers are shipped to Chicago, sold to Illinois feeders, shipped to the country to be fed and then returned to the market. This excessive handling and shipping of cattle is costly, and would not be done if steers, as good for feeding purposes, were to be had in this State. The range cattle have been rapidly improved by thoughtful ranchmen, who are grading up the native rangers with pure-bred bulls, so that steers now shipped here for feeding are in more even lots and of better individual quality than the stock which we produce on our own farms. This, coupled with the scarcity of cattle of our own raising as compared with the immense feeding resources of the state, is the great cause for feeders continuing to buy and feed range steers. Why do not those who are now feeding range steers and those who are raising scrubs, go to raising cattle which meet the demands of the market and in sufficient numbers to stock our farms with desirable cattle? They argue that we cannot compete with the ranges of the West in the production of young cattle. On the other hand, some of the leading stockmen of the state have made the assertion that we could raise beef cattle profitably even if our land were worth $150 per acre. Some of the potent reasons for this diversity of opinion are differences: First, in computation of profits; second, in methods of feeding cattle; third, in the quality of stock kept. Let us notice a few things in connection with these points.

First. In computing profits from handling stock farmers in the West underestimate, as a rule, the value of soil fertility. Feed, labor and interest on capital are figured at current rates

and opposed to the returns from the steers on the market alone, but even then good steers, if properly handled, usually show some profit. We have in Illinois great stores of soil fertility; yet the crops of recent years show that they are not inexhaustible under a system of farming which puts an enormous proportion of the crop production directly on the market in corn, oats, wheat and hay—produce which has a high manurial value as compared with its market price. Livestock returns to the soil 50 to 95% of the fertilizing elements of the food* so by meat production very little of the working capital of the soil needs to be removed from it. Then, when we consider that farmyard manure is quite as valuable in its mechanical improvement of the soil as in its fertilizing elements† we see that the manure is an item of immense importance in calculating the profits of stock-feeding.

Second. The steers which top the market to-day are as a rule those which have been kept growing at their best from the start, and have been finished for the butchers at 24 to 30 months old and weighing then 1400 to 1600 lbs. Still many steers are not fattened until they are 3 years old or over and then may not weigh as much as 1400 lbs. This shows a marked difference either in the quality or in the treatment of the steers—usually both, but more especially the latter. Experiments show without exception that the greatest profit is obtained from early matured steers.‡ The pounds of gain for pounds of feed decrease regularly as the animal advances in age; and even under the best fattening conditions the animal requires the greater portion of its food to supply the energy and heat to maintain life,§ so that the more we prolong the feeding process the more food is used up in simply maintaining the life of the animal. Most of the stockmen in this state feed an excessive amount of grain during the fattening period, indeed this is a common failing throughout the grain growing sections of the country. ‖ Cattle

*Lawes & Gilbert, U. S. Bul. 22, p. 19 and 30. Farmers Bul. 21.

†Farmers Bul. 21.

‡Prof. C. F. Curtis, Farmers Bul. 71.

§Prof. W. A. Henry, Feeds and Feeding, table p. 52.

‖Minn. Bul. 58 and 60.

will eat much more grain than they assimilate even when fattening, and the excess is a source of great waste to the feeder. Lack of sufficient amount of nutritious feed during the growing period, and excess of grain during the fattening period are both sources of loss in our cattle feeding.

Third. The beef market demands a certain form of animal, in fact the beef type is more clearly defined than the dairy type. Although in dairy cattle some forms of external details are correlated with good milking qualities, the essential thing—the yield and quality of milk—is a matter of internal constitution, and from an external examination of the cow alone, we can only speculate as to her quality as a producer. The beef animal, on the other hand, must have a certain external conformation, for this indicates exactly the amount and kind of meat in the carcass. Carefully conducted experiments have shown that a vigorous scrub steer, or one of a dairy breed, may consume as much food and gain as rapidly and as cheaply in weight as a high grade or pure bred steer of the best beef breeds. But when steers of these various types come on to the market after having been fed the same, the beef bred steer tops the market, while the scrub and dairy type go at a reduction of 20 to 30%. A steer must be well filled out with evenly distributed fat and lean meat on the parts of the carcass yielding the high price cuts of beef in order to supply the butchers' demand. This is where the scrub fails, and failure here is worse than failure at the beginning of the steer's history, for it involves greater loss and is more likely to be attributed to caprice of the market, or partiality of the buyer rather than to its real cause—poor quality of the animal.

Those who have not recognized these facts as influencing the profits of their work have been led to depreciate the beef industry, but those who have followed the course which the conditions demand have been successful in the business and now maintain that we can profitably produce good beef. *The latest work of Experiment Stations demonstrates conclusively that cattle can be raised and fattened profitably under ordinary farming conditions of this section of the country.

*Minn. Bul. 60; N. D. Bul. 33.

The idea is quite prevalent that "scrub" and "dual purpose cow" are interchangeable terms, but the scrubs which I have had an opportunity to observe have been very inferior for either of the two purposes implied, viz., milk and beef. The two purposes for which they seem to be adapted are food consumption and manure production. We must not class everything that is not registered as a scrub in this sense, for carefully bred grades of the third or fourth cross are likely to be better than some cattle that can claim pure bred ancestry. Breeders of pure-bred stock have constantly to sort out from their herds animals which may have ever so excellent pedigrees, but yet are individually of poor quality. These are usually reversions to old, ancestral types, perhaps ten, twenty or even hundreds of generations removed. Such individuals are surely scrubs, for they are just as much a nuisance as are those animals which have inherited nothing but poor qualities. This enforces the fact that every one breeding stock for any purpose whatever, whether for the beef market or for breeders, must study individual characters with a careful regard to their merit, and every inferior animal must be cut out from the breeding herd.

The thing for the average farmer to do is to follow a careful system of grading. Scrubs and mixed grades are already at hand to supply females from which to breed. Pure-bred bulls of very good quality can be had at such prices that the farmer can give his calves a first-class sire at an extra cost of only a dollar or two. The bull is more than half the herd in this case, for his individual characters are more firmly fixed by heredity than those of the cows, and it is a well-established fact that, when the two are mated together, the pure-bred animal is prepotent over the one of indifferent or mixed breeding.* Careful selection must be made of the half-bred heifers, and they must by all means be bred to a pure-bred bull.† If this latter is not done it is such a discouragingly long and difficult task to establish uniformity in the herd that none but those who are making breeding a specialty can afford to undertake it. The farmer, who must divide his attention among so many things, must take

*Darwin, Animals and Plants, under Domestication, vol. ii, p. 45.

†Ibid., pp. 74–75.

a shorter and surer course. Many failures in grading have arisen at this point. If the heifers from the successive crosses are culled closely and bred always to pure-bred bulls the quality of the herd will rapidly improve, and will constantly approach the type of the bull. A bull must not be purchased on the merits of his pedigree alone, but of both pedigree and individual excellence. Not only must he be a good one, but he must conform to the type to which it is desired to bring the entire herd; and when a change of bulls is made, the new one should closely resemble the general form of the one used before. Unless this is carefully attended to there will, after a few generations, be no uniformity among the individuals of the herd, and much of the possible good of the grading will have been lost. Pure-bred beef cattle must not be regarded as simply fancy animals intended only for the show-ring. They have been originated to fill the demand of the market, and are for everyday use, in ordinary farming circumstances, as the most economical beef producers. The farmer who lets the slight expense hinder him from grading his cattle up so as to make them infinitely more valuable to him, is simply obstructing his own progress. In the long run it costs at least as much to produce inferior cattle as good ones, and the extra price which the good ones bring on the market is just that much added to the profits.

The question as to what we are to do for milk if the cattle are bred primarily for beef has lately produced much agitation. Not all beef-bred cows are even fairly good milkers, but by no means are all of them poor ones.* Many examples can be given of cows which have the best beef qualities and yet are above the average as milkers. Indeed, some careful students of beef breeds even go so far as to say that it is possible to develop strains of cattle with the highest beef-making qualities, and yet which will compete successfully in milk with the most specialized dairy breeds.† We can rest assured, at least, that, as compared with the scrubs which we are now raising, we can get a fairly good supply of milk of good quality from cows whose brothers and sons will top the Chicago market. The milk is an important

*Prof. C. F. Curtiss, Farmers' Bul. 71; Breeder's Gazette, Jan. 11, 1899.
†Robert Bruce in Breeder's Gazette, Jan. 11, 1899.

item, and may be made a valuable adjunct to beef production; for where one is so fixed that he can make butter to advantage, he can raise the calves as successfully and more cheaply‡ on separator milk, supplemented by a ground grain ration than on whole milk. Then he will have the butter fat to market directly. In whatever way they are fed the calves must be kept growing as rapidly as possible until they are finished for the market.

It is difficult to understand why such a large proportion of our farmers should sell their steers when they are ready for fattening. These same farmers sell a great deal of grain and hay, and burn their corn fodder and straw, which they could, with very great advantage to themselves, use in feeding the cattle on their own land. Aside from the standpoint of immediate profits and the maintenance of the fertility of the farmer's land, the beef-raising and feeding industries must be combined under the same supervision, or else rapid improvement can not be expected in the quality of beef produced. Nothing but studious observation of cattle, from their birth till they are ready for the market, can make one capable of recognizing merit in young animals, and so of selecting his breeding stock wisely.

‡Yearbook, 1897.

ILLINOIS FARMERS' INSTITUTES.*

By Col. C. F. Mills, Superintendent State Farmers' Institutes, Springfield, Illinois.

The committee to whom was referred the arrangement of the program for this meeting has requested me to present a brief outline of the work of a County Farmers' Institute in Illinois.

The General Assembly, in the act creating the Illinois Farmers' Institute, has wisely placed the responsibility for the success of the work entrusted to this organization upon the county institutes, and has given the widest latitude to the scope of the operations of said associations.

The law provides that only elected and credited delegates from county farmers' institutes shall be permitted to vote in the election of the Board of Directors of this association. The directors you have placed in charge of the work of this organization are entrusted, under the statute, with the work of assisting and encouraging useful education among the farmers, and are expected to render all possible aid in developing the agricultural resources of the state. The Illinois Farmers' Institute is required by the statutes to hold a public meeting each year of three days' duration, which meeting is to be held for the purpose of developing a greater interest in the better cultivation of crops, in the care and breeding of domestic animals, in dairy husbandry, in horticulture, in farm drainage, in improved highways and in general farm management. The responsibility placed by the county organizations upon the Board of Directors of the Illinois Farmers' Institute is great and demands the earnest services of the best available talent.

It is fitting, therefore, that a convention of this character be convened and that the delegates representing more than one hundred County Farmers' Institutes be given an opportunity for conference and expression concerning all questions pertaining to

*This paper was read before the Farmers' Institute Parliament, held September 28, 1898.

the prosecution of the important work entrusted to the State and County Institutes by the act of the General Assembly. The state law contemplates that there shall be a farmers' institute held annually in each of the 102 counties in the state, and that each of said county organizations shall hold one or more public sessions each year of not less than two days' duration at some easily accessible point. County institutes, with scarcely an exception, hold three sessions on the first day and two sessions on the second day of the annual meeting, making a total of five or more sessions each year. It is safe to estimate that there will be not less than five hundred sessions of county institutes held in Illinois during the current institute season, and will be attended by not less than fifty thousand people. The estimate of said attendance is based upon the average number present at the county institute meetings held last season. How to make each of said five hundred sessions of the greatest possible benefit to the fifty thousand farmers of Illinois who will attend the institutes the coming season is the all-important question to be considered.

The committee having charge of the program of this convention has provided for a very full discussion of the various lines of work of a county farmers' institute under the eight topics announced. The ladies and gentlemen to whom said topics have been assigned will introduce the discussion on nearly every phase of institute work, and ample opportunity will then be given any one in attendance to present his views. There is not a person in this large audience of delegates representing the county institutes of the state that will question the statement that there is not a pressing demand for an "up-to-date" farmers' institute organization in every county in Illinois. It has been generally demonstrated in all sections of the state that an institute meeting, held under intelligent and aggressive management, is not only largely attended but is highly appreciated by all interested in the prosperity of the farmers of the state. We shall, therefore, take it for granted that there is an imperative demand for a farmers' institute organization in every county in Illinois. This demand can only be supplied by a management composed of the most progressive, practical and patriotic farmers residing in each county, and such a class constitute the most intelligent and successful men and women of each locality.

The majority of County Institutes are fortunate in having officers and committees composed of men and women not lacking in the desired requirements, and the meetings in such counties are generally quite satisfactory.

In view of the above facts it has been deemed advisable in the preparation of this paper to present a brief outline of the organization of a County Farmers' Institute and by means of such suggestions lead to the general discussion of the duties of officers and committees in charge of the several lines of work.

The officers of a County Farmers' Institute should consist of a President, Vice President, Secretary and Treasurer. It is recommended that standing committees, each consisting of two ladies and three gentlemen, be appointed by county institutes as follows: (1) program, (2) press, (3) finance, (4) exhibits, (5) household economy, (6) library, (7) music, (8) reception, (9) entertainment, and (10) an executive committee to be composed of the officers and the chairman of the first five committees named.

It is well to have all the committees appointed by the president as soon as he is elected, and without unnecessary delay the letterheads of the institute for the new year should be printed; said letterheads should contain the time and the place of the next institute and the name and address of all the standing committees. Supply each officer and committeeman with the institute letterheads and request them to use the same on all occasions that will advertise the institute to advantage.

The early appointment of the time and place of the next meeting as well as the selection of the best available men and women for the several committees is all important, in order that the work of preparation for the next institute may be entered upon immediately after the adjournment of the annual meeting, and vigorously prosecuted until the opening session of the succeeding yearly institute. The officers and standing committees will find no lack of important work for twelve monthly meetings, at which sessions not only the arrangements for the coming institutes can be discussed, but all matters considered that pertain to the social, intellectual and material interests of the farmer and his family.

The Program Committee is largely responsible for the success

or failure of the institute, and too much care cannot be exercised in the selection of the ladies and gentlemen composing the same. The first matter of importance in the preparation of a program is the selection of topics best adapted to the agriculture of the county. The present and prospective encouragement and direction that should be given to the development of the agriculture of the respective counties should be duly considered. A section of county best adapted to fruit should receive especial attention of the horticulturist, and all matters pertaining to the care of the orchard and vineyard, and marketing of fruit should be given due prominence. The program of an institute for a county in which the soil, convenience to market and other conditions are more favorable for dairy purposes should prominently present topics pertaining to the dairy breeds of cattle, forage plants, feeds, and the manufacture and sale of dairy products.

There is not a county in the state that is not well adapted for the mental, social and spiritual development of the boys and girls of the farm, and no program of an institute is complete that does not provide such attractions as will insure the presence at its meetings of the youth. The program committee should make the most of the opportunity to present such a line of instruction as will stimulate all in attendance to better effort in studies that will tend to make a more intelligent, prosperous and happy people.

The program committee after deciding upon the topics best adapted to the wants of the people of the county in which the meeting is held will need no suggestion as to the necessity for securing speakers who are not only practical, instructive and entertaining, but a class of men and women that have succeeded in the specialties they are called upon to discuss. As far as possible, use local talent. The afternoon session of the first day's meeting should be placed in the hands of the county domestic science association, and the ladies in charge of the same will make it one of the best meetings of the institute.

The program for the first evening session should be so arranged as to interest and instruct the boys and girls, and may well be prepared by or under the supervision of school teachers, who will esteem it a privilege to heartily co-operate with your

committee. Good crops of intelligent boys and girls with high aspirations for future usefulness are the first consideration, and will insure good crops of corn and other products of the farm.

The programs for the institute should be neatly printed, (size 6x9 inches) and contain not only the time and place of meeting, but also the names and postoffice addresses of the officers and committees, the topics of the speakers, and the names of the five local parties selected to discuss each of the papers, the list of prizes offered for displays of farm products and pantry stores to be exhibited in connection with the institute, and the names and addresses of the superintendents of the several classes of exhibits. The programs should be thoroughly distributed at least one month prior to the meeting.

The Press Committee is placed second in importance, as very much of the success of a farmers' institute depends upon the activity and earnestness of the members of this committee in advertising the meeting in the county press, the wide distribution of programs and the publication in the weekly papers of the addresses read at the annual meeting. This committee can greatly promote the work by calling attention to the institute during the year. The press committees will find the editors in their respective counties willing to publish items each week pertaining to the work of the institute. Each issue of the weekly papers published in the county in which the institute is held two months preceding the annual meeting, should contain several short articles making reference to the special features of the coming institute. Such notices should be so constructed as to interest the reader and appear as items of news. The press committee should have charge of the preparation and distribution throughout the county of the posters announcing the most interesting features of the institute, the distribution of programs and all matters pertaining to the advertising of the institute.

The Finance Committee can add largely to the success of a county institute by providing ample funds for the expenses of advertising, employing speakers, prizes for exhibits, etc. The expenses of some county institutes in the state exceed $500 per year, and such expenditures, all interested believe return a large

investment for the time and labor spent in securing the funds.

In some counties the board of supervisors make an appropriation of $100 annually to assist the county institute in its work, and no one will question the wisdom of such a procedure. The merchants in some counties contribute several hundred dollars each year in the way of prizes, and pay liberally for advertisements in the institute programs. As the matter of finances of county institutes will be presented in another paper at this meeting, this important question will be fully considered later.

The earnest efforts of the *Committee on Exhibits* will insure a large attendance at the institute of the boys and girls of the farm as well as numerous adults of a class who might not otherwise be attracted to the meeting by the papers presented. This committee will find it to the interest of the institute immediately after appointment to arrange as complete a classification of prizes for products, etc., as can be accommodated in the room or tent in which the display will be held. The interest and character of the exhibit will largely depend upon the value of the prizes and the publicity given to the same. An early canvass for premiums should be made among the merchants and others interested in having creditable display made of field products and fruit, as well as of pantry stores and other exhibits in which the farmer's wife is interested. As soon as the canvass for prizes is completed the list of premiums should be published in the county papers and slips printed for distribution. It is well to have the committee on exhibits composed of the superintendents likely to take the most interest in the exhibits: (1) live stock, (2) poultry, (3) farm products, (4) horticulture and floriculture, (5) bread, cakes and pantry stores. This committee should arrange to have a county exhibit each year at the state fair, and no better advertisement of the resources of the county can be made.

The Committee on Household Economy should be composed of the officers of the county domestic science association. Said committee should be placed in charge of the first afternoon session of the annual institute, and made responsible for the selection of speakers, topics and the general conduct of the meet-

ing. The importance of enlarging the sphere of woman's work in connection with the county farmers' institute is generally conceded, and the success attending meetings where due prominence has been given to the efforts of the women has been most gratifying. The officers of the county farmers' institutes will find no more effective agency for increasing the attendance and interest in the annual meeting than the cordial co-operation of a county domestic science association directed by a committee of representative farmers' wives, such as may be found in each county in the state.

Committee on Library. The writer is of the opinion that there should be a circulating library in connection with each county farmers' institute. A committee interested in the collection and circulation of books and papers pertaining to the farm and home, can soon gather together at little expense many of the standard works on the various studies relating to rural husbandry.

The agricultural experiment stations of the several states will gladly contribute to such libraries all the bulletins and reports as published. The United States Department of Agriculture publishes many valuable reports pertaining to the farm that will be sent upon application. The Farmers' Institute Reports of the several states stand at the head of the list of up-to-date publications of especial interest to the student of agriculture, and may be had, with scarcely an exception, for the postage. There are public-spirited farmers, business and professional men in each county in the state that will esteem it a privilege to contribute standard works, suitable to a library of this character.

Much more might be said concerning the work of a county farmers' institute, but for the limited time assigned to the topic and the desire to leave a wide field for discussion by other speakers who have had extended experience in this work. The promoters of farmers' institute work in Illinois have accomplished great things, and will, we believe, continue to spare no labor or thought necessary to make this organization a most effective agency for promoting the intelligence, the thrift and the best conditions of the physical and spiritual nature of the farmers of this state.

A STUDY OF FOODS.

By H. S. Grindley, Sc.D., Assistant Professor of Chemistry.

The study of foods for man is a subject of vital importance to all classes of people. It is a field of scientific investigation, which needs much work and careful thought and study.

The health, strength and welfare of human life largely depend upon the nutritive value and purity of foods. The power to do either mental or manual work is all obtained from the food consumed. It is, therefore, of prime importance that all who wish to obtain the most out of this life should be able to make an intelligent study and understand readily the composition of foods and to know how to select combinations and to make preparations of foods best calculated to meet the needs of the body and to insure its highest efficiency.

The University of Illinois, as the servant of the people of this state, is doing all that it can under the present conditions to forward this work of food investigation. It also desires to be as helpful as possible in distributing useful information and correctly informing the people upon this subject. The work of the University is directed to a thorough study of the composition, nutritive value, digestibility and cost of foods of all classes.

Among the food investigations conducted by the Department of Chemistry of the University, in coöperation with the United States Department of Agriculture, are two dietary studies which are briefly reported below. The results of these investigations are now being published in full by the United States Department of Agriculture, under the direction of the Office of Experiment Station and Professor W. O. Atwater, special agent in charge of nutrition investigations.

The immediate object in conducting a dietary study is to obtain information of the food materials used by different peo-

ple under different conditions of living and occupation. Another purpose is to get light upon the cost and healthfulness of the diet, and its deficiencies and the ways in which it may be improved. This knowledge can be gained only by research.

The methods which were used in making these dietary experiments are as follows: At the beginning of each study a careful inventory by weight was taken of all the food materials in the house. During exactly fourteen days all food purchased was weighed and recorded in the same way, and all table and kitchen waste was carefully collected, weighed and properly prepared for analysis. At the close of the fourteen-day period a second inventory of all the food materials on hand was taken.

The amounts of the different foods on hand, at the beginning and received during the experiment were added, and from this sum the amounts remaining at the end were subtracted. This gives the amount of each kind of food actually used. Samples of all food materials on hand or purchased during the period were secured and properly prepared for chemical analysis.

In order to estimate the nutritive value of these materials it was necessary to determine the quantity of each one of the so-called nutriments that is, those substances which nourish or promote growth. The four principal kinds of nutriments are: protein, fats, carbohydrates and mineral matters. Protein forms tissue, that is, muscle, tendon and fat. Fats form fatty tissues, and the carbohydrates are transformed into fat. These three nutriments all serve as fuel and yield energy in the form of heat and muscular strength. The mineral matters aid in forming bone and assist in digestion.

From the amounts of each kind of food actually used, and the composition of each food as shown by analysis, the total amounts of the nutritive ingredients used during the period over which the experiment extended were determined. From these weights the amount of nutriments in the waste was subtracted, and thus the amount of nutriments actually eaten are obtained.

The results of the dietary study of a teachers' family in Illinois are given in the following tables:

Table I. Weights of Food Materials and Nutritive Ingredients used in the the Dietary of a Teacher's Family.

KINDS OF FOOD MATERIAL.	FOOD MATERIALS.	NUTRIENTS.			
		PROTEIN.	FAT.	CARBOHYDRATES.	COST.
PER MAN PER DAY.	GRAMS.	GRAMS.	GRAMS.	GRAMS	CENTS.
Beef, veal, and mutton	116	18	24	....	
Pork, lard, etc.	101	16	53	....	
Poultry	74	11	1	....	
Fish	60	6	3	....	
Eggs	74	10	7	....	
Butter	49	....	42	....	
Cheese	22	6	7	1	
Milk	277	9	11	14	
Total animal food	773	76	148	15	15
Cereals	262	33	7	192	
Sugars and starches	182	3	0	172	
Vegetables	501	10	1	54	
Fruits	282	2	1	54	
Total vegetable food	1227	48	9	472	12
Total food	2000	124	157	487	27

Table II. Nutrients and Potential Energy in Food Purchased and Eaten in Dietary of a Teacher's Family.

		NUTRIENTS.			
		PROTEIN.	FATS.	CARBOHYDRATES.	FUEL VALUE CALCULATED.
PER MAN PER DAY.		GRAMS.	GRAMS.	GRAMS.	CALORIES.
Food Purchased.	Animal	76.	149.	15.	1758.
	Vegetable	48.	9.	472.	2215.
	Total	124.	158.	487.	3973.
Waste	Animal	15.	35.	5.	409.
	Vegetable	8.	10.	41.	292.
	Total	23.	45.	46.	701.
Food Actually Eaten.	Animal	61.	114.	10.	1349.
	Vegetable	40.	1.	431.	1923.
	Total	101.	113.	441.	3272.

The results of this investigation show that the daily food of an instructor of the University contained the following amounts of nutrients: Protein, 101 grams (3.6 ounces); fat, 112 grams (4.0 ounces); carbohydrates, 441 grams (15.6 ounces).

In Table III a summary of this dietary is compared with dietary studies of professional men made in other sections of the United States.

TABLE III. Comparison of Dietary No. 1 here reported with others made in United States. (Per Man Per Day.)

	Cost of Food.	Nutrients. Protein	Fat.	Carbohydrates.	Full Value	Nutritive Ratio.
	Cents.	Grams.	Grams.	Grams.	Calories.	
INSTRUCTOR'S FAMILY, University of Illinois.						
Food { Purchased	27	124	158	487	3973	
Food { Waste	....	23	45	46	701	
Food { Eaten	....	101	113	441	3272	1:6.9
AVERAGE OF NINE DIETARIES OF PROFESSIONAL MEN, Storrs Agricultural Experiment Station.						
Food { Purchased	25	110	136	442	3530	
Food { Waste	....	3	7	5	100	
Food { Eaten	....	107	129	437	3430	1:6.8
PROFESSIONAL MAN'S FAMILY in Pennsylvania						
Food { Purchased	22.3	98	155	396	3465	
Food { Waste	....	7	10	16	185	
Food { Eaten	....	91	145	380	3280	1:7.8
TEACHER'S FAMILY in Indiana.						
Food { Purchased	18	111	110	349	2910	
Food { Waste	....	5	8	9	130	
Food { Eaten	....	106	102	340	2780	1:5.4
PROPOSED STANDARD. American (Atwater.)	....	112	....	....	3000	1:5.5

The results of a dietary study of a boarding club of mechanics is shown in the following tables:

TABLE IV. Weights of Food Materials and Nutrients used in Dietary of a Club of Mechanics.

WEIGHTS.

KINDS OF FOOD MATERIAL.	FOOD MATERIALS.	NUTRIENTS. PROTEIN.	FATS.	CARBOHYDRATES.	COST.
PER MAN PER DAY.	GRAMS.	GRAMS.	GRAMS.	GRAMS.	CENTS.
Beef, veal and mutton......	242.9	42.4	32.4	.3	
Pork, lard, etc..............	118.9	14.4	53.5		
Poultry....................	19.2	1.6	.4		
Fish.......................	34.3	6.3	1.4		
Eggs......................	61.2	7.5	5.5		
Butter.....................	70.2	.8	57.4		
Cheese....................	20.2	4.5	2.3	.8	
Milk.......................	248.9	6.7	9.1	12.7	
Total animal food......	815.8	84.2	162.5	13.8	14.
Cereals....................	291.3	31.5	6.6	167.7	
Sugars and starches........	126.2	.3	....	124.3	
Vegetables	732.1	10.3	.9	67.3	
Fruits.....................	205.6	1.7	.8	18.4	
Total vegetable food...	1355.2	43.8	8.3	377.7	9.
Total food.............	2171.0	128.0	170.8	391.5	23.

TABLE V. Nutrients and Potential Energy in Food Purchased and Eaten in Dietary of a Boarding Club of Mechanics.

WEIGHTS.

		NUTRIENTS. PROTEIN.	FATS.	CARBOHYDRATES.	FUEL VALUE.
PER MAN PER DAY.		GRAMS.	GRAMS.	GRAMS.	CALORIES.
Food Purchased	Animal............	84.2	162.5	13.8	1913.1
	Vegetable.........	43.7	8.4	377.7	1805.1
	Total	127.9	170.9	391.5	3718.2
Waste	Animal............	7.1	18.7	1.6	210.2
	Vegetable.........	4.0	6.3	10.9	119.7
	Total	11.1	25.0	12.5	329.9
Food Actually Eaten.	Animal............	77.1	143.8	12.2	1702.8
	Vegetable.........	39.7	2.1	366.8	1685.5
	Total............	116.8	145.9	379.0	3388.3

The results of this study show that the daily food of a mechanic contained the following quantities of nutrients: protein, 116.8 grams (4.1 ounces); fat, 145.9 grams (5.1 ounces); carbohydrates, 379.0 grams (13.4 ounces). These food nutrients, in this case, were supplied at a cost of twenty-three cents per day.

In order that an intelligent study and comparison may be made, in Table VI, a summary of this dietary is compared with similiar studies of the families of mechanics made in other parts of the United States.

TABLE VI. Comparison of Dietary No. 2 here reported with others made in United States. (Per Man Per Day.)

	COST OF FOOD.	NUTRIENTS. PROTEIN	FAT.	CARBO-HYDR'TS.	FUEL VALUE.	NUTRITIVE RATIO.
	CENTS.	GRAMS.	GRAMS.	GRAMS.	CALORIES.	
BOARDING CLUB OF MECHANICS, Illinois.						
Food { Purchased	23	127.9	170.9	391.5	3718.2	
Food { Waste	....	11.1	25.0	12.5	329.9	
Food { Eaten	....	116.8	145.9	379.0	3388.3	1:6.1
AVERAGE OF NINE DIETARIES OF MECHANICS' FAMIMIES, Connecticut.						
Food { Purchased	....	113	153	420	3605	
Food { Waste	....	7	11	14	185	
Food { Eaten	....	106	142	406	3420	1:6.8
MECHANIC'S FAMILY IN Indiana.						
Food { Purchased	26	106	157	475	3840	
Food { Waste	....	16	23	67	555	
Food { Eaten	....	90	134	408	3285	1:7.9
MECHANICS FAMILY in Tennessee.						
Food { Purchased	16	119	224	455	4435	
Food { Waste	....	9	14	43	345	
Food { Eaten	....	110	210	412	4090	1:8.0
MECHANICS FAMILY in New Jersey.						
Food { Purchased	28	103	144	431	3530	
Food { Waste	....	3	6	6	95	
Food { Eaten	....	101	138	425	3435	1:7.4

These dietary studies, like similar investigations made elsewhere in the United States under the direction of the Department of Agriculture, show that there are some errors common in the use of food. In the first place, we eat food which as a rule does not contain the proper proportions of the different kinds of nutritive ingredients. As a people we eat too much of the heat producing constituents of foods, such as the fats of meats and sugar and starch. On the other hand, our foods do not contain enough protein or flesh forming substances, like the lean of meat and the gluten of wheat. This nutrient makes muscle and sinew, and is the basis of blood, bone and brain.

In the second place, most of the dietary studies which have been made in the United States show that in almost all cases there is a needless waste of food nutrients. This waste is due to two causes. In the first place, we eat too large quantities of food for the health and strength of the body. In the second place, there is too much waste, due to carelessness in cooking and the lack of knowledge and the realization of the actual quantities of food which is thrown away in the table and kitchen wastes. These facts are also shown in the above dietary studies.

CORN AND THE HOG.

By Louis D. Hal_, Class of 1899

The bacon hog has of late years been the subject of a good deal of discussion, and a product so closely related to King Corn may well receive the consideration of every farmer in the West. The development of the American hog and the extensive introduction of American pork into foreign markets are results of feeding Indian corn, and it is everywhere admitted that no other feed available to the western farmer can be fed to his hogs so cheaply and at the same time so successfully. The physiologist, however, tells us that corn alone does not form a well-balanced ration for the hog, and reminds us that in his natural state the diet of the snouted hunter is made up of a large variety of foods, from acorns to earthworms. When we restrict him to a ration made up of corn, therefore, we are preventing him from making his highest development, so far, at least, as size and strength are concerned. Further, we are warned by the statistician that the demand for leaner pork, together with the introduction of cottolene and mineral oils in the place of lard and lard oil, is causing a discrimination in the market against the lard hog, such as a plain corn diet must necessarily produce. Although he acknowledges these facts, still the feeder is in doubt as to how far he may profitably venture in combining other feeds with the corn which goes into his hog pen, and he is inclined to question whether the composition of the feed really makes any difference, after all, so long as his pigs eat it, grow into fat hogs and sell for about the market price. Any facts, therefore, which will help to remove this doubt from the mind of the feeder will be of direct value to him.

A large number of analyses of corn show that it contains, on the average, 10.6 per cent of water, and 89.4 per cent of dry matter. After drying the sample the chemist burns it to find the amount of ash present. Deducting the ash and water, two kinds of substance remain, viz: nitrogenous and non-nitrogenous. All the nitrogenous ingredients (albuminoids) are called protein. These compounds have the most to do with building up the

muscles, bones, internal organs, etc. The non-nitrogenous part is of two kinds, carbohydrates and fats. These contain carbon and may be called the "energizers" or work-producing nutrients. When the supply of these nutrients in the food is greater than the activities of the animal demand, they are stored in the tissues as fat. The carbohydrates of corn are made up almost entirely of starch, with a small percentage of fibre, and hence corn is called a starchy food. Many experiments have been conducted for the purpose of determining what proportion of each of the different nutrients can be digested by animals; and when the scientist tells us that corn alone is not a well-balanced ration for the hog, he means that it does not contain enough digestible protein in proportion to the digestible carbohydrates and fat—that is, the ratio of the nitrogenous to the non-nitrogenous digestible ingredients is too small for the normal development of the body. This ratio is called the nutritive ratio. The following table gives the dry matter and digestible ingredients of corn, with that of some other feeds placed beside it for comparison, and with the nutritive ratio of each.

TABLE I. *Digestible Nutrients and Nutritive Ratio.

Kinds of feed.	Dry matter in 100 pounds.	Ash in 100 pounds.	Digestible nutrients in 100 pounds.			†Nutritive ratio.
			Protein	Carbohydrates	Fats.	
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
Shelled corn	89.4	1.5	7.9	67.0	4.3	1:9.9
Oats	89.0	3.0	9.2	48.3	4.2	1:6.3
Peas	89.5	2.6	16.8	51.8	.7	1:3.2
Shorts	88.2	4.6	10.8	55.9	4.0	1:6.0
Green rape	15.5	2.9	1.5	8.1	.2	1:5.7
Green cowpeas	16.4	1.7	1.7	7.2	.1	1:4.4
Green clover	29.2	2.1	2.9	15.0	.6	1:5.7
Green alfalfa	28.2	2.7	3.9	11.9	.5	1:3.4
Sugar beets	13.5	.6	1.1	10.2	....	1:9.3
‡Skim milk (Centrifugal.)	9.5	.7	2.9	5.2	.3	1:2.0

*From Bul. 15, U. S. Dept. of Agr.

†Nutritive ratio= (digestible carbohydrates + 2.4 × digestible fats) ÷ digestible protein.

‡From Feeds and Feeding, Henry.

It is easily seen, from the column of nutritive ratios, that corn is a highly carbonaceous food as compared with the others. In Canada, peas are fed almost as exclusively as corn is fed in the Middle-Western States, and the contrast between these two distinctive hog feeds is at once apparent. Each is the cheapest feed in the region in which it is grown, and each must continue to be *the* pig-feed of its section, while some of the others must be fed to a sufficient extent to supply the demands of the animal's body and to furnish the market with the quality of pork which it demands.

With a comparative knowledge of the composition of corn, we may more intelligently study its effect in producing pork; and an understanding of nutritive ratios is of no particular value unless we determine which ratio or combination of nutrients makes the most profitable feed. In an experiment at the university last summer six pigs, in three lots of two each, were fed (1) corn, (2) corn with all the green feed they would consume (rape, cowpeas and sugar beets being fed successively) and (3) corn with oats in the proportion of 3:1. As the experiment was begun just as the animals were weaned, a thin slop made of shorts and water was given to all the pigs in order to keep them in good condition. The following table shows the average weights, gains, feed consumed, nutritive ratio and estimated cost of gains:

TABLE II. Average Results of Feeding Pigs Corn, Corn with Green Feed and Corn with Oats for Three Months.

No. of lot.	Weights.			Food consumed.				Nutritive ratio.	Gain per 100 lbs. of corn.	Cost of 100 lbs. gain.
	Beginning.	Close.	Gain.	Corn.	Shor's	Green feed.	Oats.			
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.	dols.
I.........	52.0	96.6	44.6	179.8	35.2			1:8.0	24.8	2.86
II........	48.6	102.4	53.8	179.6	35.4	247.6		1:7.8	2.99	2.64
III.......	50.7	88.2	37.5	113.4	34.7		37.8	1:7.3	33.	3.18

The largest gain was made by the pigs of lot 2 on a ration of corn and green feed, and the smallest by those of lot 3, which were fed on corn and oats. Practically the same amount of corn was consumed by lot 1 (corn alone), and lot 2 (corn and green feed); much less was eaten by lot 3 (corn with oats), showing that while the addition of green feed to a corn diet augments the gain without reducing the amount of corn consumed, the addition of oats lessens the amount of corn which the animal will eat, and at the same time reduces the gain. For a true comparison of the effects of the three rations, however, we must reduce all the results to a single standard. We may disregard the shorts, since all three lots were fed practically the same amount. Assuming 100 pounds of corn as a basis for comparison, we have the following gains corresponding:

TABLE III.

Lot I. —100 pounds corn	24.8 lbs. gain
Lot II. —100 pounds corn and 137.7 pounds green feed	29.9 lbs. gain
Lot III.—100 pounds corn and 33⅓ pounds oats	33.0 lbs. gain

By subtraction we find that 137.7 pounds of green feed are accountable for 5.1 pounds of gain (although this increase must be attributed largely to the advantage which a mixed ration always has over a simple diet, other things being equal), and in the same way 33⅓ pounds of oats are accountable for 8.2 pounds of gain. Again, reducing our results to a standard of 100, we have:

TABLE IV.

Lot I. —100 pounds corn	24.8 lbs. gain
Lot II. —100 pounds green feed (fed with corn)	3.7 lbs. gain
Lot III.—100 pounds oats (fed with corn)	24.6 lbs. gain

Although 100 pounds of corn made more pork when fed with 33⅓ pounds of oats than when fed with 137.7 pounds of green feed (Table III), we must remember that while the pigs of Lot 3 were eating 100 pounds of corn apiece and making an increase of 33 pounds, those of Lot 2 were each consuming nearly *160 pounds of corn and making about 48 pounds of pork, and each pig of Lot 1 was also eating about †160 pounds of corn and gaining about 40 pounds; hence the difference which Table III

*Calculated from Table II.

†Calculated from Table II.

shows in favor of oats is only proportional and not real. We conclude from Table IV that a pound of oats, when fed with corn in this proportion, produces about the same amount of gain as a pound of corn—by the combined effects of its feeding value and the variation of diet which it gives—while six or seven pounds of green feed are required to make the same increase. Therefore, since a pound of oats ordinarily costs nearly twice as much as a pound of corn, oats is ordinarily an expensive feed when given with corn in this proportion; and since seven pounds of green feed ordinarily cost but little more than one-half as much as a pound of corn and produce the same amount of pork, it must be an economical feed when fed with corn in about the proportion named above.

And besides making a cheap feed for the *growing* pig, a ration containing some such succulent food as those used in this case brings the animal into a condition which enables him to eat more corn and give better returns for it during the following months than he could do after dieting on corn alone for the first three months of his life as a grain-eater. Here lies an advantage which is of the highest importance, for the whole problem in pig-feeding is to find the cheapest way of turning our corn into pork.

The figures in the column which shows the relative cost of the gains would of course vary greatly with market prices, locality and special conditions, but the experiment indicates at least that growing pigs can be fed at a profit, since the conditions in this case were necessarily unfavorable in some respects. The cheapest gain, as well as the largest, was made with corn and green feed, while the pork produced by three parts of corn to one of oats was the least profitable. But the latter ration gave the narrowest nutritive ratio of the three, showing that the cost of producing pork with any ration depends far more upon the kind of feed and its acceptability to the animal than upon the nutrients which it contains or the proportion of one kind of nutrient to the others. We must know what our animals will eat best, and give those feeds, if they are economically available, in such a way as to induce the largest consumption of them. "The eye of the master fattens his herd," and if the

feed is merely thrown into the pen the result is sure to be unsatisfactory, whether the nutritive ratio be wide or narrow.

The results of but one experiment are given here. They plainly indicate the value of succulent feed for pigs, and show that rape and cow-peas, which are not yet widely grown in Illinois, can be successfully used for this purpose. They would be fed most cheaply by turning the pigs into the field and saving the expense of harvesting. Both are cheap, convenient crops to raise and should be familiar to every progressive farmer in Illinois. Other experiments have demonstrated the value of clover, alfalfa, ensilage, bluegrass pasture and other feeds of this kind as part of a ration for hogs; and while there is yet much to be learned by experimentation with such feeds, if the Illinois farmer will make judicious use of such of these crops as are easily available to him, in combination with his corn, he will be convinced of the fact that pig-feeding pays, and the bacon hog will before long be a thing of the present.

THE

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PREFACE

THE previous issues of THE ILLINOIS AGRICULTURIST have been received with such keen interest by both farmers and students that we feel the publication is no longer an experiment, but a thing of established value and usefulness. The agricultural students and professors composing the Agricultural Club find in it a means of communicating the results of their studies to their friends who are busy with farming, and the latter find in its pages a store of practical information on the most vital questions that concern their business. In this issue, as in the previous ones, we have attempted to present the most recent information available, and yet to make no statements which may be misleading nor advance ideas as facts that have not been fully proved. The material given is based on experiments of the writers, and on careful studies of the work of other reliable investigators. The articles by students indicate to some extent the nature of their regular studies; indeed, they are mostly such as are prepared in class work. They will give to the prospective agricultural student a small insight into the very interesting and practical nature of the studies he will pursue at the University.

We believe that something in detail as to the condition of the College of Agriculture and its courses of instruction will supply information which our readers desire, and particularly so since the college has lately advanced with great rapidity. During the last year the force for instruction has been doubled and the number of students increased from 21 regular and special students and 26 short course students, to 90 regular and special students, the short course having now been discontinued. But the crowning success of the year is the new building, for which $150,000 was appropriated, and it is now being rapidly erected. For this reason we have given a prominent place in this issue to a discussion of matters concerning the College of Agriculture. It is, of course, in this college that we are primarily interested, but the aim of this publication is not only to disseminate information concerning the college, and to encourage young farmers to attend it, but also to advance the work and increase the general interest in scientific agriculture. The Agricultural Club will account the publication a success if it shall, even in a small way, contribute to these results.

Finally, we wish to extend our thanks to contributors and advertisers. THE ILLINOIS AGRICULTTRIST is entirely dependent upon advertising and private subscription for its support. We are, therefore, deeply indebted to our many patrons for their generous support, without which this publication would be unable to come before the public.

February, 1900. E. T. R.

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PRACTICAL EDUCATION.*

By T. J. Burrill, Ph.D., Professor of Botany and Horticulture

Soon after the middle of the century now almost at an end, when northern Illinois was still a very new country, a farmer's boy seventeen years of age, very robust in body and alert mentally, visited a blacksmith shop and became greatly interested in seeing the man at the anvil skillfully making horseshoe nails. It seemed an easy thing to heat just right the end of the iron rod at the forge and then to hammer out the well-shaped nail. The idea took strong possession of the boy that he would like to try his hand and perhaps take up the trade. Gaining good-natured permission and with appropriate instruction, he undertook the task only to find that seeing the work done was one thing and doing it himself was quite another thing. The hammer proved too heavy or too clumsy. The directive forces of his brain failed. The proper form, so easy to distinguish in the well-finished nail, was not clear in the iron rod. That first trial was a complete failure so far as the nail was concerned and was a disappointment to the boy. He really wanted to succeed, but he did not know how to proceed.

At a later time a company of college graduates, fresh from their studies, with awakened mental powers, with keen interest in life, with highly colored ideas of future accomplishments, joined a party for a summer's outing and exploration in Colorado. They had no purpose of engaging in mining, yet every one would have risen earlier in the morning and would have increased immeasurably his activities during the day, if he had thought by so doing he could have become the rightful possessor of a goodly quantity of Colorado gold. They did indeed visit the mines

*Written for the Illinois Agriculturist. Read at the meeting for 1899 of the Central Illinois Horticultural Society, with slight modification of the text.

and became assured of great deposits of the precious metal. But they went, week after week, over the mountains, enjoying the exercise and the scenery, securing some collections for the museums at home, spending the money previously saved for the journey and at length returned, sublimely unconscious of what they had missed. They had encamped upon the now famous fields of the Cripple Creek district and had unconcernedly slept upon extemporized beds directly over some of the richest deposits in the world. They did indeed get returns of certain kinds for their labors, yet have not quite forgiven themselves for their lack of the kind of information that would have permitted them to make better use of their opportunities. They did not know how to do so. Their schooling offered nothing in this direction.

A citizen of a thriving town in Central Illinois had succeeded in accumulating in legitimate and perfectly proper ways, a very considerable fortune. He retired from business at a comparatively early age, while it was still possible for him to engage heartily in affairs. He thought he was now going to take life easy and enjoy the remainder of his days. But in the earlier times he had made no special acquaintance with books or with the lives of other contributors towards the worlds history. He would now gladly have spent time and money in enriching his own mental possessions, and as gladly if possible have aided others in a similar manner. There were indeed open fields for abundant efforts of this kind, but he did not and could not appreciate his opportunities. He was anxious in his way, honest in his purposes, but powerless in initiative. He did not know how. He said to a friend: "I made a mistake; now I have just wit enough to see it, but not enough to remedy it. I was prepared for the business I pursued, but I was not and am not prepared for the higher life I ought to enjoy and ought to be able to help in others. My boys must do better. At all events they shall have a chance."

A woman, scarcely in middle life, found she had, all unbeknown to herself, been providing for her family food far from what it should have been in the interests of physical, mental, and moral development and well-being. She was a lady of refinement and had made excellent use of her opportunities for

literary and social culture. She had a goodly share of what is commonly called wealth. A husband and children were however the dearest possessions she enjoyed and the best that imagination could picture for her. For their welfare she was ready, to the extent that only a wife and mother ever demonstrates, to do anything and sacrifice anything. When it was in part too late, she became aware of the immense importance of proper food upon the score of bodily health and brain power. What would she have then done to win back to life a little household treasure, an innocent, winsome creature absolutely dependent upon not only the mother's love but upon her hygienic knowledge as well! Now would she have set fashion at defiance and the ordinary routine of table furnishings at naught, if by so doing she could have preserved life and health for her loved ones. But she did not know. There was a most responsible office to fill, one that she would have been ambitious to magnify; but she was not only unprepared to discharge properly its duties, she was unconscious of real responsibilities resting upon her and of the possibilities of discharging them.

These instances taken from actual life can be duplicated and multiplied by any of us at will, of failures, often momentous in character, due to the want of sufficient and suitable preparation. We have each and all of us suffered in this way. Our losses have often been apparent to us. We can easily see that we have failed variously to make the most of opportunities open to us. But the worst failures are those of which we do not even know. We have not been even wise enough to perceive that golden privileges have been right in our way. We heedlessly pitch our camp over the gold mine, then go away and pick gooseberries, fortunate perhaps that we do not gather therewith something poisonous. Or we barter for money and its getting, the most precious, the most enjoyable, the most helpful, the most endurable, and the most satisfying things of life.

It would be however quite as easy and certainly more pleasurable to recall examples of success through educational preparation and outlook. Few lives are simply fortunate. Men and women who find it possible to review their past careers with reasonable satisfaction, know that the turning points have

been open to choice. They can usually see that the things accomplished are to be credited to direct and determined effort. A man was once asked how Richard Yates came to be governor of Illinois. The reply, "O I suppose it was luck" did not satisfy the questioner, for he immediately rejoined "But why shouldn't luck, if that was it, favor the other fellow?" When something is found it is usually looked for; when something is accomplished it is by one who knows how; when life is successful it is because the aims have been correct and the efforts have been adequate.

Now education is or should be a preparation for life. It is for the human being, subject as he really is to all his natural and necessary limitations, to all of the actual and influential conditions by which he is and is to be surrounded and subjected. It is or should be a real preparation for a real life. So far as the latter is of the earth earthly, so far the preparation should be of the earth earthly. So far as life in its best estate is above earthly things, so far also should training fit and culture lead the way.

We sometimes hear it said that the American people are too sordid, too exclusively hunters of the almighty dollar, too much given to business, and not enough to social accomplishments, to art, to polite learning, to ethical culture. Now since the fountains of the brain are in streams of red blood, and since the highest aspirations of the soul are dependent upon gastric digestion, it becomes us to look well to the material side of our being that the other may exist at all. Preparation for life must indubitably include that which deals with our daily bread. A bread and butter education is a good education as far as it goes, and for the great mass of mankind it must go a very long part of the life distance. Without it everything fails. With it a foundation is laid for the loftiest superstructure One cannot enjoy good literature upon an empty stomach, and a man cannot be a patriot who is harrassed with debt. Indigestion is now recognized as a cause of immorality as well as imbecility; drunkenness and gluttony follow naturally in the train of an improper food-ration. Would we make men temperate, benevo-

lent, devoted, charitable, religious,—let us see to it as fundamental that they are skilled in some trade or occupation and that they are so well and intelligently prepared that success is feasible and that effort is pleasurable. The man or woman well employed and well fed has little occasion to complain of physical or mental dyspepsia. Such people sleep well at night and awake with cheerful readiness to undertake the new tasks of the new day. They help themselves and are the foremost to help others when occasion requires it. The so-called accomplishments are all well enough in their place, but they play small part in human existence and progress compared with matters connected with the things that directly minister to what we call "getting on" in the world. We therefore do very wrong when we so shape our system of instruction that the merely cultural studies receive prominent attention at the expense of those more closely connected with the necessities of ordinary livelihood; and any want of appreciation of the latter as compared with the former shows something incorrect in the estimation of what life really is, and for what educational enterprises are really maintained.

Now the word practical in connection with the word education has been variously defined. One would call all education which tends to help towards physical, mental and moral development, practical education. Anything according to this idea which has the result of building up manhood and womanhood into better stages of development should be considered as practical as anything else can be. Another would limit the term to the preparation for business and for the needs of our material existence. In this sense arithmetic is deemed practical because made use of in accounts, while an introduction to general literature and the fine arts is not to be so included. Therefore according to the latter view, the subject matter is to determine largely whether or not the resultant education is to belong with that now under discussion.

This distinction is not however as obvious as it would seem from the statement. In fact the subject-matter is of comparatively small importance in brain-building, with which education

of all kinds has so much to do. There is no food-ration for the mind comparable to that known to exist for the body. Not that material food-ration does not effect the brain; it does and we need to know more about it and to study the relation more carefully; but there is no combination in the elements of mental pabulum suggestive of the percentages of the formulated ration for the stomach. The important thing in education is how the work is done, how the mental faculties are aroused, stimulated into action, and kept in motion. The mind gains strength if its capacity is strained, but it may move sluggishly equally without current and without increase of power. Hammering upon cold iron makes little impression, but blows upon the red-hot metal modify its shape and consistency. The brain needs to be put in the receptive stage of red-heat if vivid pictures are to be produced and mental power augmented. Therefore the first consideration in education is *interest.* The pulpil must first be interested, awakened, his intellectual appetite sharpened. It used to be supposed that a birch rod was a good stimulus. The pupil was pushed into heroic activity through fear of punishment and if there were no better means of securing vigorous effort we might still advocate the switch. But the modern method, when indeed method is consciously pursued, is to try to present the subject-matter so as to engender wide-awake attention and hearty application. If this can be done by the use of one kind of subject-matter better than with another, then the first thing is the selection of wise instructors, and in that sense it does matter, on the discipline side, what studies are included in the curriculum. In this sense the rough and tumble tussle on the foot-ball team may be of much more service in the development of the mental faculties than a much greater time spent in pouring over books in a half-hearted, perfunctory way. The same may be said of manual training, in or out of school, in comparison with the usual lessons and recitations. In fact there is sometimes greater educational value in various activities of youthful and adult life in which mental culture is not usually thought of at all, than there is in the routine affairs of school. We talk about men being self-made, meaning thereby that they have gained what they possess without the aid of the organized machinery of the

schools. But all who ever gain much mental power are, in this same sense, chiefly self-made whatever their opportunities may have been.

There is further, in spite of what has just been said, another factor in education that helps to minimize the subject-matter in the evolution of mental capacity and moral sensibility. If enthusiasm, vigor of application, counts prominently, the teacher and his special qualifications and abilities must be considered. In what work is he most successful in stimulating earnest and active exertion on the part of pupil? There is often a marked difference. No teacher does his best unless his own interest is aroused, unless his heart is in his work. Students understand very quickly whether or not this is the case, and even if nothing is said about it the resultant effect is soon marked. Happy the young person who gets quickened by a spark from off the glowing altar of a teacher's enthusiasm in any subject of study. A start so made is worth a thousand times more than any dry store of accumulated recipes and rules however long the time of acquisition or however direct the application is supposed to be to the end in view. If we are all mostly self-made the largest part of the exception must be reserved for the influence of others in the communication of spirit and living interest rather than in help toward the accumulation of information. We can and usually will help ourselves when once so aroused. It is indeed a dull individual who does not make the effort to eat when he is hungry, and the hunger of the mind is certainly as coercive as that of the stomach. The latter soon becomes satiated, the former never does. The more one knows, the more he wants to know; the more he grows mentally, the more his ambition rises for further growth, the more apparent is the necessity for further nutriment of the same kind as that before utilized.

All this has been said to show the comparatively small attention that need be given to the subject-matter in education either of, or out of, the schools. That the most importance should be given to whatever quickens intellect and arouses self-action cannot be doubted. The same subject can not be the best for all minds for we are not all made alike in the first place, and not all can have the same quickening conditions and inter-

ests. In schools the personal, special aptitudes of the teacher must plainly be allowed considerable sway, and the idiosyncrasies must always be allowed to count as important.

But we may yet compare practical subjects in the sense of those evidently most nearly related to affairs with those not clearly so connected. We have said that there is no formulative food-ration for the mind. Mental growth is based upon mental activity. There is no other substance or process whereby mentality may be increased. There is, it is true, some difference in the kind of activity engendered in work upon different kinds of subjects. In one case the memory may be mainly exercised, in another the powers of observation, or of logical judgment, etc. Leaving this out of the discussion for the time being, is it not presumable that those things called practical are as likely to arouse attention and stimulate interest as others? Young persons, in the olden times, used to be whipped for making pictures on their slates. This not because the pictures were bad or of improper subjects, but because time was supposed to be wasted that ought to have been used for something else. Now the ability to draw well is of great practical utility. May it not be true that the educational value of learning to draw is as great as learning the capes and promontories of Africa, or the exceptions to rules in the grammar of a foreign language?. If one would make a good picture on paper, he must first have a good picture of the object in his mind. He must transfer the appearance of the object to the paper by a mental process as well as by a pencil. He must study and correctly estimate relative size. This means mental activity, and the action must be nicely regulated, accurately coördinated, or the result will very quickly show defects. Picture making from objects trains the eye, making vision sharper and the interpretation more certainly correct; and it trains the hand, making it a better servant and better able to do the behests of the will. This training is education, and useful not only to artists, but all persons whatever their calling in life. It cannot be less valuable in education because it may be turned to a direct account in a professional career and in the earning of a livelihood. It used to be forbidden upon the ground in part that it was something the pupil

wanted to do, was interested in doing. Surely this pedagogical absurbity should be recognized as such, and the importance of natural interest in work should be made helpful towards scholarship.

Chemistry taught experimentally in the laboratory is a fascinating study to most young people. There is no longer a question as to the value of such experimental laboratory work in education, or to its service in mind discipline. Is the subject and the method less important in these respects because the information thus obtained may be turned to account in the workshop and the kitchen? Or is it likely that the interest in the study, so indispensable pedagogically, will be less because of the subsequent utility of what is so learned? Is it not strange rather, that thoughtful men, carefully considering the whole matter, and honestly endeavoring to make school work the best possible in an educational sense, should ever have reached the conclusion that practical utility, viewed from the standpoint of subsequent life, was not to be made a part of the problem of the school room, or if to be thought of at all was only to be recognized that it might be excluded, like weeds in a garden? But the idea of mental discipline has been deemed so far separate from usefulness *per se* that some educators have allowed their best thinking to lead them into this foolish and deplorable absurdity. The schools are still suffering from it to a greater extent than is usually comprehended. Teachers have, too, accepted the customs of the past without sufficient scrutiny as to whether the change in the conditions properly permits the following of former practices. The time was when there was little that could be substituted for the so-called classical studies in a curriculum. But this ought not now to weigh in favor of these subjects when other matter is abundant. Yet he who completes a classical course in college commonly accounts himself above, in true scholarship, his friend who with equal ability and assiduity has spent his time upon the literatures and sciences of his mother tongue. In the ideal cases as argued by some, the former has given little heed in school to the part he is to take in life. It is only necessary to fit himself for enrollment among people of refinement and of mental culture. Let some one else

prepare to tend the store or to run the farm. Work is not in his line. Working people are not in his class. But the second has tried to shape his school work with reference, in considerable part, to his life work. He feels ready for business and every day after commencing business has reason to remember his instruction, for it fits his life. The acquisition of money does not hinder his accumulation of knowledge, nor his growth in mental power. One helps the other, and all make the man. One educated in the first method may be successful, but the second is at least as likely to make his mark among his fellows and to win distinction for high thinking as well as for good living, and the road to the latter at least is much straighter.

This brings us, by so long and round-about a way, to the inquiry of the needs npon the educational side of the farmer and the gardener, the agriculturist and the horticulturist. If what precedes means anything it is that, first of all, in the educational process, glowing interest should be aroused, a burning, unquenchable thirst begotten, and that the subject matter which, under the circumstances and with the teacher, will best do this, is so far the best to enter upon. After this the kind of knowledge which will most surely be most helpful in life must be selected. This again means that the same course of study can not be best for all persons and under all circumstances, even if they are all to follow the same occupation. It means, too, that methods of approach or of presentation must be carefully considered and ultimately ordered upon rational pedagogical principles. A pure science which has become well organized upon the teaching basis may be, and probably will be, better than any application of such science not yet so organized, and this in spite of the fact that the latter has more bearing upon practical affairs. Until within the last decade, or at most the last two decades, school instruction in strictly agricultural and horticultural subjects has not been very fruitful in results. There were enough facts known but they had not been marshalled into order; they were not in teaching order, and the appliances at hand were not sufficient. At the agricultural colleges one man, and one alone, was commissioned professor of agriculture. His teaching was mainly limited to applications

of sciences and to handicraft methods of procedure. It is now understood that the agricultural sciences and arts are altogether too much for one man to master and to teach. Instead of one man there are now in the most successful institutions quite a group of investigators and teachers devoting themselves to what may be called technical agriculture. One, for example, has the subject of dairying, another of stock feeding and breeding, another of farm crops in all their relations and differences, another of farm mechanics and architecture, etc. Then the lecture method of instruction formerly in vogue, and the only method open for one man covering the whole range of subjects, is supplemented by or abandoned for the laboratory method. Students make their own experiments, under such direction as will make the work most beneficial, educationally and practically. A series of experiments is so arranged that the outcome of the first helps toward the completion and understanding of the next. The interest of the student grows as he progresses, and little other stimulus to hard work is found necessary.

For example, the older method of giving instruction in the composition and characteristics of soils was to have a few samples on the table before the class, and, with these for illustration, a lecture was delivered upon the subject. Now, the laboratory is fitted with balances, sieves, gravity apparatus, microscopes, tubes and vessels of various styles and shapes, pulverizers, tests for chemical reactions, apparatus for physical measurements, etc., etc. Natural soils of typical and of certain peculiar kinds are on hand in quantities, and a regularly planned series of examinations and tests has been previously arranged for clearly understood purposes. The students themselves make the investigations and write out the results. When they have finished they have the assurance doubly sure that they know something, not by quoting some one as authority, but at first hand; and the knowledge is in such shape that practical use can and will be made of it in the field. Very often, a much different meaning is attached to words after such a study. For instance, it is everywhere taught that plants take food elements from the soil in a state of *aqueous solution;* that is, the mineral substances necessary for plant nutrition are taken from the soil

by absorption by the roots. But such studies as have just been referred to soon convince the student that the term solution must be understood to mean matter in the molecular state *but not suspended in water*, for most plants grow best in soil in which there is no water in the free or liquid state. The water in soil, damp enough for plant growing, is *in a solid form* in physical combination with the earthy particles. The roots simply pull off from the solid mass, molecule by molecule, either water, or lime, or potash, or phosphates, as necessity requires. In this manner a cabbage will take more sulphur and a potato more potash from the same soil, with perhaps the same amount of water. Interest is at once awakened as to how this is done; how roots can select, and this again leads on to other inquiries, all of which bear upon the final results and help to an understanding of many otherwise unanswerable questions. Once started on such investigations there is small danger that the student will rest satisfied until he has more than completed the tasks laid down. He is a discoverer. The strain and stress of the coveted prize is upon him. He is a victor, and the enthusiastic shout of triumph may well be excusable. By the knowledge he gains he is also gaining that dominion over his environments promised him in the beginning by the Creator of all.

Taught in such a way, and with the instruments of research in hand, there is no longer any likelihood that agricultural subjects will be found lacking in stimulating power. There is, then, no reason to bar them from a scheme of general education open to all persons. But if they are at the same time of high importance upon the practical side, and of direct utility to the presumptive agriculturist, there is a double reason for the latter's attention to them.

The same thing may be said of the specifically horticultural subjects. Here the field is a narrower one than in technical agriculture, but the objects are more diverse and the subdivisions more clearly marked. It, in general, requires an acquaintance with more details and greater niceties of discrimination to be a good general horticulturist than an equally equipped agriculturist. The market gardener's work is different from that of the orchardist; and the landscape artist, creat-

ing his pictures out of doors and from natural materials, has a very different task from that of the vine grower. All this, however, means interest in teaching, provided suitable provisions are made for it. But to teach horticulture solely, or mostly, by the lecture or text-book method, is sadly at variance with modern thought and good pedagogical procedure. How long would it take a lecturer to make plain and certain to a class the individual characteristics of a hundred kinds of apples? If bright persons should at length memorize the descriptions so given, how long would they be remembered? The way to know apples is to study *apples*, not words or even pictures. The way to learn how to spray apple trees is to spray trees, with the actual apparatus made for that purpose.

We talk about teaching agriculture and horticulture in the common schools. There is no reason why something of this kind chould not be thus introduced. Little gardens can be grown in the house and sometimes outside. A few plants in pots may furnish the basis for good instruction, and objects of many kinds can be brought to the premises for illustrating simple lessons; but all this can no doubt be better done under the head of *Nature Study* than as specific agriculture. As just explained, the sciences and arts included under the terms agriculture and horticulture need elaborate equipment, and specialists as instructors. The laboratories and experiment farms of a technical college, with abundant resources and specially provided facilities, are required for this work.

The state of Illinois has not been foremost in making such provision, notwithstanding the fact that Illinois leads most others as an agricultural state, and has possibilities beyond all precedent in our country. But a new era is dawning. An immense advance step has been made. For twenty-five years there were in the University in Urbana one professor of agriculture with at most, one assistant other than ordinary workmen; and there was less than half a professor of horticulture, for botany was supposed to receive his first attention, and he never had more than one assistant or foreman. Today however there are employed in these departments engaged in instruction and in experiment station investigations, and giving their whole time to the work,

at least ten men each one a specialist in his particular field. Heretofore, until very recently, there have been small opportunity for laboratory methods of instruction and no provision of special apartments adapted to the work in hand save an ordinary barn and a little dairy building. Now the foundations are in, and the work of building is progressing for the largest, best appointed, most complete group of agricultural and horticultural structures in America, to cost as planned one hundred and fifty thousand dollars. Further than this there has been provided, aside from salaries, a fund from which needful expenditures can be made, as much larger in proportion over that previously available, as the increase otherwise shows. This magnificent forward movement is due to the public agitation during the last few years thus securing a favorable attitude of the state legislature. Time and again state aid had been asked for this purpose by the University authorities, but the efforts uniformly failed until presented to the last general assembly. It was very soon apparent that a change had been wrought and that nothing would be allowed to gain precedence over the appropriation for these agricultural buildings. For this favorable change in the minds of the senators and representatives great credit must be given to the State Farmers' Institute, to the State Horticulural Societies, and to the Agricultural Press. To the present president of the State Horticulural Society more than to any other one individual, must be accorded the honor of the final result.

In conclusion the idea may be reiterated that education should be very carefully and wisely planned, with attention from the beginning to the end that it must be a real preparation for a real life in order that this life shall be both the richest possible and the fittest possible for the individual whatever his vocation and surroundings. To gain these purposes due consideration must be given those things upon which the daily living so much depends. In other words, education should be as practical as life is rational, and should be adjusted to the essential needs of life in the various callings or pursuits as well as to the full development of man as man.

AGRICULTURAL ADVANCEMENT AT THE UNIVERSITY OF ILLINOIS

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The year that has passed has been a notable one for the agricultural interests of the University. The last General Assembly appropriated $150,000 for a building to quarter the agricultural departments and to provide facilities for their work. This is the largest sum ever voted at one time for such a purpose, at least in America, and it has provided a building, or rather a group of buildings, that can but challenge admiration, whether viewed from their size or from their fitness for the purpose to which they will be devoted. Four separate buildings, connected by corridors, are ranged around an open court. The main portion is two hundred and forty-eight feet long, from fifty to one hundred feet deep and three stories high, and is devoted to offices, class rooms, laboratories, etc. The three wings are each forty-five by one hundred and sixteen feet, and two stories high—one devoted to farm machinery, one to stock judging and one to dairy manufactures and domestic science. It is a little over a quarter of a mile around the entire group, and the total floor space is something more than two acres.

Aside from all matters of utility, there is an inspiration in such a building, which, combined with the sense of consequence and responsibility arising from such surroundings, cannot but induce better work and a higher regard for a calling that engages half the people. Only time will fully demonstrate the effect of all this upon the student body, upon the status of agriculture at the University, upon the development of the industry and the betterment of its people over the State at large.

But this is not the only, nor indeed the principal feature of the new conditions enjoyed by this college. The financial support is largely in excess of that of previous years, and this has

permitted an entire reorganization of the work of instruction. This new order of things recognizes the fact that the fundamental condition and necessary precedent to good instruction is a proper development of the subject in the hands of a sufficient number of people to fairly cover the matter involved, and it admits that the cost of instruction is primarily dependent upon the nature of the subject rather than upon the number of students to be taught. Quite naturally, in a matter so prominently before the public, the people are desirous of knowing the nature and extent of the changes that have been inaugurated at the University respecting agriculture and facilities for its study.

Briefly, the funds are going into better equipment for teaching, and into an increased number of instructors. The latter have been increased from six to twelve. The question is often asked, "Why so many teachers for a limited number of students? Cannot half the number attend to a hundred boys?" Yes, in one or two subjects, but if they have the inherent right to study forty subjects, No. The number of instructors was increased not because of numbers of students, but because of the nature of the subjects that ought to be taught in agriculture and because of the right of the individual student to good instruction, which is not to be denied or abridged because there is but one of him and not a hundred. If this work is to be done at all, it is to be done well, or the student is not only cheated out of money and time, but given false and inadequate standards to plague him through life though he made the attempt to be an educated man. As was anticipated, the better facilities for teaching have led to a substantial increase in students.

In the early attempts to teach agriculture the chief aim was to drill the student in those farm practices that experience has found to be most successful. This was a mistake because it overlooked the very essentials of education and mistook the methods and purposes of instruction.

Running through the affairs of men are fundamental principles, great natural laws whose operations determine the outcome of things. Because these laws are many and often antagonistic, their relations are exceedingly complex and their resultant at best most difficult to foresee. The practices of a profession

represent merely those operations that upon the average have been found most successful. They are the best makeshifts known, but do not imply any knowledge of the principles involved. Quite the contrary they often exhibit the most profound ignorance of such principles, and indeed often date back to a time when even the existence of natural laws was not suspected. These practices are things that have grown up from the beginning and are not uniform for the same profession at different periods, among different peoples or in different localities; they should not, therefore, form the basis of education.

Now the distinguishing feature of an educated man is that he knows the principles involved in what he undertakes to do. The teacher is not to content himself with a recitation of practices. He must analyze these practices, discover the fundamentals involved and make them the basis of instruction. If, therefore, agriculture is to be well taught, it will be done only by first ascertaining its great natural divisions and by putting a man in charge of each to develop its lines of thought, to discover its facts and principles and set them in order for study. Agriculture is not simple, but complex; it is not a single subject, but many subjects, and herein lies the mistake that has for generations ruined the best attempts to teach it.

As an object of study or a subject for instruction, there is vastly more difference between the corn plant and the soil in which it grows than there is between the Latin and the French languages. Horticulture and veterinary science are as far apart in subject-matter and lines of thought, as are chemistry and medieval history, and either is further removed from the peculiar problems of animal husbandry than is zoology from botany. They are all agriculture, only because they all pertain to the farm, but each has its own peculiar problems for the student and there is little in common. Each will develop an identity of its own, and practices will become more rational as study of principles deepen and as conditions and relations become more fully outlined and better understood.

The agricultural subjects are undergoing the same evolution that the sciences have passed through. Thirty years ago we heard much of the "Professor of Natural Science." Now we

have professors of zoology, entomology, embryology; of physiological, systematic and cryptogamic botany; of physiology and a dozen different branches of pathology; of geology; of physics; of electrical engineering; and of more branches of chemical, biological and physical science than most fairly well informed people ever heard the names of. This has come about, not through number of students but through evolution of the subject, and because assiduous study has developed infinite ramifications in the little known and nowhere respected thing sometime called "natural science." The history of Agriculture as a teachable subjecf will be the same, and it will develop teachable matter and establish clear cut subdivisions in proportion as the field is divided and assigned to specialists.

Believing this most firmly, the University under the new conditions has taken radical ground, and, with little respect to traditions and former customs, has set itself to ascertain what in truth are the leading features of agriculture that should be developed as fundamental lines of thought and study to constitute the basis of instruction; and it has put a man in charge of each to develop it and to teach it. These great leading subjects, each representing the central thought of the work of one individual and around which all instruction clusters, are as follows:

1. Soils.—What the agriculture of a country may be is absolutely determined by its soil, and it is therefore a fundamental object of study. We study soils as to their origin and their relations to moisture, heat and fertility, which are the essentials of plant growth, and if the soil by nature does not afford the conditions that would secure maximum crops, then its proper management is of all questions in agriculture the most fundamental. One man devotes his entire time to this single line of study—to the physical and mechanical condition of soils and to the organisms that inhabit them.

2. Crops.—The inherent natures of the different agricultural crops are also fundamental objects of study, first to discover the conditions that must be provided for each to insure the largest yields, and second to determine how the plant may be further improved by proper selection and breeding. It is for the instructor in this subject to inform the student of soils as to the

conditions that are required by the natural appetite of the various crops; and it is for the soil man to devise means of affording these conditions. This is the only sane method of studying this question, and the only one that separates principles from practices, essentials from tradition, fundamentals which are eternal from ways and means which are dependent upon a thousand seasonal and local conditions that will never again occur in the same combinations.

3. Fertilizers, Rotation and Fertility.—To secure the largest continuous returns from a given soil is not a question of a particular crop or of a single season, but rather of the influence of the crop upon the soil and upon succeeding crops. Next to good government, this matter—the fate of fertility and the retention of the productive capacity of soils—is the largest of all public questions because it is the most far-reaching in its consequences. This subject is taught by the head of the department of agronomy, and is distinct from either of the two previously enumerated.

4. Breeding and Feeding.—There is no more profound study for the farmer than the principles and practices by which domestic animals can be further improved and by which they can be so nourished that the young may be properly developed and the animal products may be economically produced.

5. Stock Judging.—A critical knowledge of what man has domesticated and of the particular type best adapted to our various needs is fundamental to him who expects to keep live stock. It is not enough that he know the written history of these breeds, nor even that he be able to recite their established characters. He must have a well-trained eye for differences, amounting almost to an instinct which is unerring in detecting the first symptoms of wandering from the type. All this is distinct from the principles of feeding and breeding; the field of knowledge is not the same; the personal skill of the successful teacher is of a different order, and one man devotes himself to each separate line.

6. The Dairy Farm.—The making of milk is now an industry as distinct as the lumber business, and how to produce a standard article that is free from contamination and fit for

direct consumption or for manufacturing into any of the dairy products, is one of the great questions in food production for the people. To teach it requires an intimate knowledge of dairy conditions; of the organisms that live in milk, of the proper surroundings of the cow, and sanitary methods of handling milk.

7. DAIRY PRODUCTS.—The methods and the machinery involved in the manufacture of butter and of cheese of different grades are both many and intricate. They call for special knowledge and skill quite independent from that required for other lines, and the University has done wisely to put two men in charge of the dairy department.

8. FARM MACHINERY.—Nobody who is familiar with the extensive use of machinery on American farms, of its influence in cheapening the cost of production, and certainly no one who is familiar with the almost universal abuse to which it is subjected can doubt the wisdom of establishing classes for the study of this subject under the charge of a man who devotes his entire time to it and to the problems that arise out of it.

9. FRUITS AND FLOWERS.—If there is a feature of agriculture that should be developed and that requires a specialist to do it, it is certainly that which deals with the fruits that garnish the table and sustain the health, and the flowers and trees that beautify the home. It is handled by two instructors and will one day be yet further divided, for the field is broad with its hundreds of plants and scores of enemies, under both out-door and in-door conditions.

10. VEGETABLE GARDENING.—This branch of horticulture differs from fruits and flowers, in that not only the plants are different, but the location and the methods of business of the two have so little in common that they are not followed to any great extent by the same individuals, and one instructor pays particular attention to this subject.

11. THE DISEASES OF DOMESTIC ANIMALS.—This is also distinct and requires special knowledge and skill to such an extent as to fully employ the time and energies of one instructor.

It has not been at all difficult to separate these eleven distinct lines of work. They are based upon the principles involved

and are therefore natural. As they take form and as their identity becomes established instructors and students are finding that unheard of possibilities are to be found in each; and as investigations are pushed further than was ever before possible when "one man taught agriculture" principles are appearing and operations are becoming rationalized.

The development and subdivision of these eleven primary lines of study afford some fifty distinct offerings in the different branches of agriculture. In each the student fixes his attention along a definite line and makes the most exhaustive study of that subject that the genius of the instructor can inspire, and time and subject-matter will permit. The plan not only develops agriculture as a teachable subject but it develops men as independent students skilled in the principles involved and disposed to shape practices according to conditions.

No short course is conducted. Students either enter the course leading to graduation, about half of which is fixed and requires four years, or they enter the different subjects as special students without reference to graduation. In either event the "subject" and not the "course of study" is the unit. The possibilities of this system in the development of agriculture and in meeting the needs of students must be evident to the reader. It is capable of extension indefinitely, and this extension is limited only by the forces available.

SOME CAUSES OF LOSS OF VITALITY IN SEEDS

By Donald F. Berger, Class of 1902.

In May, 1896 an experiment was begun to determine the effect of certain conditions on the vitality of some of our common farm seeds. For this purpose a quantity of corn, oats, wheat, rye, buckwheat, millet, clover and timothy seed was selected, and the vitality of each determined. Taking the average of over thirty samples, the vitality of the corn was about 90%, varying in different samples from 76% to 96%. No figures are at hand to show the vitality of the other seed. The seed was from the crop of '95, and had been kept dry and in good condition. In putting the seed up in bottles, etc., the different varieties were mixed together in as nearly a constant ratio as could be done conveniently, except that in part of the experiment corn alone was used.

Some of the seed was put into ordinary 8-oz clear glass bottles and hermetically sealed by pushing the cork well down into the neck of the bottle, filling up the neck with sealing wax, and over this putting a layer of Portland cement. A dozen one gallon earthen jugs were also filled about half full of seed and filled like the bottles. These jugs, with as many bottles, were then buried three feet under ground. Another dozen of sealed bottles were set on an upper shelf in a seed room where they were fully exposed to the light, and where the temperature was allowed to vary with every change of outdoor temperature. The remainder of the mixed seed was put into four large bottles with ground-glass stoppers, such as are commonly used for holding acids, the stoppers of which could be shaken a little, and so were not perfectly air-tight. It was put in these for no special purpose, but simply to have on hand a supply of that particular seed, in case it should be wanted later on. It should be noted

that two of these bottles were of clear, uncolored glass, another of light-blue glass, and the fourth of dark-blue. They were placed on the other end of the shelf where the sealed bottles were. The seed was thoroughly dry when put in the bottles.

In October, 1899 those seeds that had been buried were dug up, and a jug and two bottles were opened, the rest being put back in the ground. The seed in the jug was damp to the touch, and looked somewhat soured, but showed no sign of mould or rotting. That in the bottles was dry, looked as fresh as when first put in. At the time of digging the ground was dry enough to crumble readily down to the depth of the jugs. In November samples of seed from the jug, from one of the bottles from the ground, from one of the sealed bottles on the shelf, and from each of the glass-stoppered bottles were tested for vitality in in-door germinators, with the following results:

Table giving % that had germinated at the end of 96 hours (S. B., sealed bottle; B. B., buried bottle; J., jug).

	Corn.			Oats.			Wheat.			Rye			B'ckw't			Millet.			Clover.			Timo'y.		
	J	B B	S B	J	B B	S B	J	B B	S B	J	B B	S B	J	B B	S B	J	B B	S B	J	B B	S B	J	B B	S B
First trial	0	96	0	0	100	0	0	70	0	0	24	0	0	52	0	0	57	0	0	59	37	0	65	0
Second trial	0	100	0	0	92	4	0	80	0	0	30	0	0	60	2	0	32	2	1	76	37	2	74	0
Third trial	0	90	0	0	66	0	0	60	0	0	25	0	0	42	0	0	75	0	0	86	55	0	77	0

This second table gives the % of seed from the glass-stoppered bottles that had germinated at the end of 96 hours, except with the clover and the timothy, where the time is 9 days:

Glass-stoppered Bottles.	Corn.		Oats.		Wheat.		Rye.		Bckw't		Millet.		Clover		Timo'y	
	Clear	Dark blue	Clear	Dark blue	Clear	Dark blue	Clear	Dark blue	Clear	Dark blue	Clear	Dark blue	Clear	Dark blue	Clear	Dark blue
First trial	64	72	84	88	62	70	0	0	40	54	15	29	57	46	55	35
Second trial	24	36	86	70	42	58	0	0	28	48	26	50	17	18	34	59
Third trial	56	76	88	78	44	62	0	0	22	30	4	26	18	36	14	40

(For convenience the seed from the sealed bottle that was buried will be spoken of as that from the buried bottle, and the seed from the sealed bottle set on the shelf as that from the sealed bottle. As the seed from one of the clear glass-stopped bottles, and that from the light blue one has not been tested as thoroughly as has that from the other two, only the results obtained from the dark-blue bottle and one clear one are given in the table, and only these will be considered. So far the data obtained which is not given would have little if any influence on the conclusions drawn.)

The loss of vitality in the seeds in the jug was undoubtedly due, indirectly, to the presence of excessive moisture; that is, adverse conditions, such as cold, and possibly freezing in this

case, were much more effective in the presence of this moisture than they would otherwise have been; not that the moisture alone was specially injurious. The way in which the seeds from the buried bottle germinated would indicate that the conditions under which they were kept were quite favorable for the preservation of vitality. But those seeds sealed up in the same way, but set on the shelf instead of being buried, hardly germinated at all. Since the bottles were hermetically sealed in both cases, the first thought is that the light is responsible for the difference, and it will be noticed in this connection that the seeds from the dark-blue bottle germinated uniformly better than those from the clear bottle. Whatever may be the effect of light on seeds in a dormant condition, it is evident that it is not the only factor in determining the behavior of these seeds, because in the matter of light the seeds in the sealed bottles and those in the clear glass-stoppered bottles were under quite similar conditions. Yet the latter germinated more than half as well as seeds from the buried bottle, while the former hardly germinated at all. The fact that the seeds from the clear glass-stoppered bottle did not germinate as well as those from the buried bottle would make it seem probable that the light had some injurious effect, especially since those from the dark glass-stoppered bottle were less injured than those from the clear one. But in addition to the effect of light, it is very probable that part of the loss of vitality in the various seeds exposed to the light was due to the numerous and rather wide changes of temperature to which they were subjected. The reasons for the almost total loss of vitality in the seed in the sealed bottle, while that in the clear glass-stoppered bottle, which was about equally exposed to light and to changes of temperature, will be considered later.

As to the effect of moisture, it has already been said that the loss of vitality in the seeds in the jug was indirectly due to the large amount of moisture present. It is impossible to state the relative amount of moisture in the buried bottles, as no moisture determinations have been made; but during the three and one-half years that the bottles were buried there may have been more or less passage of moisture into or out of them, though

the seals were in good condition when they were dug up. There was little opportunity for change in the sealed bottles on the shelf. As the glass stoppers in the other bottles were not absolutely air-tight, there was probably some exchange of air accompanying the changes in temperature, and this would allow of gradual changes in moisture. It is impossible, however, to state just what the moisture conditions have been in the several cases, and what has been their effect. It may only be said that seeds generally retain their vitality best when kept reasonably dry.

But the conditions so far considered do not account for the almost total loss of vitality in the seeds in the sealed bottle, and not in the glass-stoppered bottles, especially in the clear one, which was under conditions very similar to those of the sealed bottle. It should first be noticed that the glass-stoppered bottles were only about half filled with seed, so that the volume of air in them was more than equal to the volume of the seed; while the sealed bottles were almost full, the volume of air in them being probably less than one-fifth the volume of the seed. As already seen, there may have been more or less exchange of air, too, in the former, but not in the latter. Now it is known that apparently dormant seeds carry on a slow process of respiration, *i. e.*, free oxygen is taken up and carbonic acid gas given off when the seed is exposed to free air, and this has also been observed in seeds confined in sealed tubes with a small quantity of air. Experiment has shown that this respiration is not necessary for the preservation of the life of the seed, as seeds have been known to retain their vitality for years in a vacuum, where respiration is impossible; but it has been shown to take place, to some extent, wherever air is present. The actual amount of carbonic acid gas present in any of the sealed bottles has not been determined, but it may be that there was enough of it developed to account for the loss of vitality in these seeds, as its presence in considerable quantity has been found to be quite injurious to the vitality of seeds. In fact no case has been found where any seeds retained their vitality after being kept in nearly pure carbonic acid gas for some time. The much greater amount of air present in the glass-stoppered bottle would

so dilute the gas there as to render it comparatively harmless. This would satisfactorily explain the results obtained in the two clear bottles, were it not for the fact that, so far as the presence of air is concerned, the seed in the buried bottle, which germinated best of all, was in practically the same condition to start with as that in the sealed bottle on the shelf, which hardly germinated at all. But in all other conditions, such as temperature, moisture of the surrounding medium, and light, the buried seed was so different from that in either the sealed bottle or the glass-stoppered bottle, that it is hardly comparable with them.

It is to be regretted that more has not been determined in regard to the changes that have taken place in the seed and in the air in the bottles, as this would make it possible to give a more satisfactory explanation of the results. But the experiment shows clearly that the vitality of seeds depends very largely on the conditions to which they have been subjected. It is not enough to have good seeds properly harvested. They must be well cared for and protected from all adverse conditions up to the time of planting, if they are to germinate quickly and vigorously. It is necessary, of course, that the seeds be good to start with; but no matter how good the seeds may be at first, if they are not properly cared for they will not germinate well when planted. It has been noticed by seedsmen that if one of two packages of equally good seed be sent into the Southern States and the other into the Northern, the seeds sent south will often become worthless in a single season, while the others usually retain their vitality for several years. This is but one example of the remarkable effect of seemingly slight influences.

The cause of the loss of vitality in seeds is a question that has received surprisingly little attention. Considering its practical importance, and in view of the great annual loss to our farmers resulting from the use of poor seed, it is certainly a question that merits careful scientific investigation. From our present knowledge, the best conditions in which to preserve our common seeds are, to have them thoroughly air-dried, and keep them so; to keep them in a medium temperature, with as little variation as possible; and keep them in comparative darkness. Some questions suggested by the present experiment are: To what

extent does light affect the vitality of seeds? What is the effect of light on the respiration of seeds? What degree of moisture is most favorable for the preservation of vitality in seeds? What is the most favorable temperature, and within what limits may it vary with safety? The answers to these questions would probably vary somewhat with different varieties of seed.

One thing is perhaps worth noticing that is not directly connected with what has been said. In that part of the experiment in which corn alone was used, the corn was put in flasks containing various gases and sealed by melting the neck of the flask together. They were then packed away in a box in the room with the other seeds. They were opened with these, but on putting them into the germinators for testing they were found to be much more liable to the attacks of bacteria and moulds than the others, so much so that in spite of special precautions they were thickly covered with mould, and some had begun to rot before they had any opportunity to germinate.

Mr. Henry Augustine, of Augustine & Co., Normal, Illinois, has proved himself to be one of the most helpful men in the advancement of the horticultural interests of Illinois. He is one of the few nurserymen who is prominent in the more important affairs of the State Horticultural society and who contributes largely to the progress of practical and theoretical horticulture in this region. He has gained a well earned reputation as a business man and people have learned to trust what he says about his commercial enterprises.

FRUIT GROWING IN NORTHERN ILLINOIS.

By J. W. Lloyd, B. S. A., Instructor in Horticulture.

Northern Illinois is primarily a grain and dairy region. Fruit growing has never been a leading industry; and now the old family apple orchards, planted in the early days, have passed their period of usefulness, the cherry trees have died a natural death, the currant and gooseberry bushes have fallen victim to the currant-worm, and the grape vines are allowed to ramble unrestrained over their trellises. The markets of the larger towns are being supplied mainly with fruit grown in other regions, the smaller towns and country places are almost "fruitless," and the farmer's boy grows up without knowing what it is to be turned loose into a patch of ripe strawberries.

Twenty years ago, the thrifty farmer's wife would not think of entering the winter without a goodly supply of canned cherries and currant jelly, but for the last ten years cherries and currants have been exceedingly scarce in the very region where they were once so abundant. The farmer has been busy caring for his other crops and has let his fruit plantation take care of itself. When the old trees and plants died there were no new ones coming on to take their places, so many farms have been left practically without fruit. To be sure, the rotting remnants of old orchards still continue occasionally to produce a scanty crop of small, gnarly apples that will do for cider; but the rows of apple barrels in the cellar are no longer present.

Fortunately a reaction seems to be setting in, and many farmers are planting fruit trees in small numbers. Some of these young trees are being well cared for, but many of them are simply stuck into holes in the ground and left to fight their own battles against June grass, weeds and drought. Of 156 plantings of young trees which came under my observation during the summer of 1898, just one hundred, or nearly two-thirds of the total number, were in sod.

While the above outline fairly represents the status of the average farmer of Northern Illinois with reference to fruit growing, there are a few men who have largely directed their attention to fruit, and the success of those who have given their plantations proper care shows that the region is not destitute of capabilities in the line of fruit production.

The chief hindrances to successful fruit culture in Northern Illinois are hot, dry summers, late spring frosts, severe winters, insects and fungous diseases. This array of "hindrances" is not so formidable as might at first thought be supposed. The injurious effects of the summer drought can be largely obviated by a thorough-going system of tillage, thereby conserving the moisture in the soil instead of allowing it to escape by evaporation. The late frosts of spring are usually light and are confined to the lower lands. Much of the country is of a rolling character, so that there are plenty of ridges and slopes on which fruit may be planted and be safe in most years from any frosts which may occur after blossoming time.

The liability to winter injury is probably the most serious obstacle we encounter. Hardy varieties must be selected, and proper care given so that the plants will make a strong, healthy growth and enter the winter with their wood properly ripened. The experience of last winter (1898–'99) ought not to discourage us, nor cause us to cease planting fruit. The peculiar combination of circumstances which resulted in the severe winter injury may not occur again within the present generation. From the middle of June until nearly the last of July the rainfall in Northern Illinois was exceedingly slight, and the soil, especially in uncultivated areas, consequently dry. This condition would tend to check growth and cause the trees partially to open their wood. Toward the end of July copious rains began to fall, and continued in abundance throughout the entire month of August.* This bountiful supply of moisture tended to promote a new growth in the trees, and to leave them in the worst possible condition for entering the winter.† And when

*See "Weekly Crop Bulletin" of the Weather Bureau.

†See article by Dr. T. J. Burrill in Transactions Illinois State Horticultural Society, 1883, p. 224.

the cold wave came, and the mercury sank to the bottom of the thermometer and staid there for over a week, it was at a time when, in many localities, there was no snow whatever upon the ground; consequently the soil was frozen solid to an unusual depth. Such a combination of circumstances *ought* to be enough to test the hardiness of even the ironclads. Instead of being discouraged, we should take advantage of this opportunity to learn what varieties can withstand so severe a test, and also, what methods of culture will put a tree in proper condition to best endure a severe winter. A thorough investigation would probably reveal the fact that those plantations which were properly cultivated during the dry weather, suffered less injury than those that were neglected. More trees are killed by neglect than by the cold of winter.

Insects and fungons diseases can be controlled by proper attention to spraying. As previously intimated, the disappearance of our once-abundant currant and gooseberry bushes is due largely to the currant-worm. While conversing with a successful grower of small fruits, I asked him if he was bothered much with currant-worms. "Not a bit," was his ready reply.

"Why, don't you have any?"

"Yes, have plenty of 'em, but they don't bother me any; I just give'em one dose with my spray pump and that's the last of 'em."

So it is with other fruits. The men who spray thoroughly are able to grow fruit notwithstanding the pests of orchard and garden.

What fruits can be grown in Northern Illinois? After carefully considering the climatic conditions, visiting several fruit plantations, and conversing freely with their proprietors, I am led to the conclusion that there is no adequate reason why the Northern Illinois farmer could not raise an abundant supply for his own use of the following fruits: Apples, pears, sour cherries. grapes, raspberries, blackberries, currants, gooseberries, strawberries. It is true that the blackberry canes are often injured in winter, and that the fruit frequently dries upon the bushes. Both these difficulties can be overcome by proper treatment. It is a simple matter to lay down the bushes in the fall and cover

them with earth for protection. So feasible is the plan that it is practiced on a commercial scale in many places. In some localities it will be necessary to protect raspberries and grapes in a similar manner. The drying of berries on the bushes can be prevented by thorough cultivation, begun early and repeated at frequent intervals.

Peaches, although exceedingly liable to winter injury and not to be generally depended upon, will now and then give a fair crop if planted in a favorable situation. I know one man who has secured five crops during the last eight years; but this is an exception. Most of the peach trees with which I am acquainted have yielded only one or two good crops within that time. Northern Illinois is plainly not a peach country; and this fruit should not be planted except in an experimental way.

The local markets afford a good opening for the farmer who will grow more fruit than his own family can use. Good fruit is always in demand. The farmer who can deliver his fruit direct to the consumer, or to the retailer, has an advantage over the distant grower in that his fruit reaches market in better condition and he avoids the expense of transportation. Summer apples, cherries, gooseberries and strawberries are the fruits from which the average grower can probably make the most money in the local markets; though the type of fruit that can be most successfully grown and most advantageously marketed, will depend largely upon the ability of the grower, his local conditions and the demands of his market. The prices realized in the local markets are largely independent of Chicago prices—even though the market be somewhat near Chicago—especially when the freshly-picked fruit is delivered direct to the consumer. This applies particularly to the more perishable fruits, like strawberries. But even such staple products as summer apples sell readily in many towns at one dollar per bushel for very ordinary stock. The Oldenburg is probably the most profitable early apple to grow.

It is probable that Northern Illinois cannot compete with New York, Michigan and Southern Illinois in the production of winter apples for general market, nor will it pay to grow small fruit for the Chicago market. They ripen at a time when that

market is already flooded with Michigan fruit. Grapes, also, are not a profitable crop to grow for the general market.

Is there, then, no fruit which we can profitably grow for the general market? Yes, there is one fruit for the production of which Northern Illinois seems to be very favorably situated. That fruit is the sour cherry. Before the trees died of old age, the Northern Illinois farmer used to count upon his cherry crop with almost as much certainty as his corn crop. It was not unusual for a man to pay the rent of his entire farm from the product of a three-acre cherry orchard. Notwithstanding this fact, the cherry industry has been neglected. The renter had no incentive to plant trees, and the owner did not seem to care; so when the old trees died there were no new ones to take up their work, and the money for rent had to be raised in some other way. Within the last few years the interest in cherries has begun to revive, and the few men who have embarked extensively into the business are meeting with success.

While we can afford to grow cherries for the Chicago market, better prices can be realized by shipping elsewhere. Situated as we are, near the northern limit of successful cherry culture, and on the main lines of railroad leading to the northwest, we can practically control the markets of Wisconsin, Minnesota and the Dakotas; and until these markets are fully supplied, they, together with the local markets, will probably offer the best inducements to our cherry growers.

Each succeeding year emphasizes the importance of spraying. There is no longer any doubt that the operation is based on rational principles and is demanded by the increasing incursions of insects and fungi, yet a man says, "I sprayed this year and it did no good. Shall I spray next year?" A man may insure a barn this year and it does no good; but he insures it next year. * * * * The experiences of a single season do not prove nor disprove things which are true. We know that sprays kill insects and check the spread of fungi; and we know that insects and fungi are with us. Lay out a course of action to accomplish a desired result; modify your practice as the case requires, but stick to the action. L. H. BAILEY.

FERMENTATION.

By H. E. Ward, M.S., Instructor in Soil Physics.

The question of fermentation is by no means a new one. Should we attempt to seek the place in history where those changes, which the scientist of today includes in the category of fermentive processes, were first observed and studied, we should be compelled to go back to a period when most of our sciences were yet in their infancy or were still unknown. We find that the ancient Romans were familiar in a general way with changes of this nature, and in some of the writings of Pliny and Columella that have come down to us especial reference is made to the subject of the normal fermentations of the soil as being of great importance in the application of fertilizers. The latter writer mentions certain substances such as the excrement of birds, marl and lime which were supposed to favor in a marked degree the occurrence of these changes, and which for this reason were highly esteemed as manures.

Not only by the Romans but by many other peoples have changes which are fermentive in character been observed and studied. It was no doubt such observations as these which led to the discovery of the different processes of making fermented drinks, which have been so largely used by various peoples since the earliest times. In many other ways such as the spontaneous changes occurring in food-materials, the souring of liquids, the action of leaven in dough and the decaying of organic substances in general were they constantly confronted with phenomena of this nature. The importance of these changes has been emphasized by the great degree to which they have influenced the comfort and well-being of the people, especially those living in temperate or tropical climates. Stimulated by the vital significance of the questions which often-times confronted them, men were led to regard these changes with

wonder and to endeavor to explain their origin; and as a result of the queries which arose it was eventually discovered that all changes of this character were primarily due to a living cause. It was this discovery and the limited state of the knowledge concerning these mysterious living things which gave rise to the erroneous theory of "Spontaneous Generation," a theory which was so generally accepted and which clung so tenaceously in the minds of many able men that its overthrow was only accomplished in comparatively recent years.

Although this is a question which, owing to its intensely practical nature, has attracted the attention of the people at large, as well as of the scientists of every age, yet we find that there is still a large degree of vagueness and misapprehension in the minds of most people regarding its true character. To their minds the term fermentation implies in some indefinite way a mysterious change by which the sweet juice of the apple is transformed into "hard" cider. The general absence of a more definite idea of the nature of fermentation is, however, quite excusable when we consider that it is only in recent years that this subject has been comprehended, by those who have given it special study. Though the investigations of the past few years have thrown much light upon the character of the changes which take place during fermentation, yet many of these changes are still shrouded in mystery and even the most skilled investigators are unable to explain them. We have already seen that people have been acquainted with fermentation in a verv superficial way for a great many years, yet the study of the nature of these changes and their causes is still in its infancy. If we accept the importance of the results already obtained in their practical bearing upon the health or happiness of mankind as a just criterion of what may be expected from future studies, then this field surely becomes one of greatest promise.

Some of the studies upon the nature of fermentation indicate that the changes which attend it belong to that class of chemical processes which are analytic in character. These changes are attended by a splitting up of the substance acted upon, or a division of it into two or more products of a simpler chemical

constitution. In this way, then, highly complex chemical substances are resolved always into simpler compounds, a process by which they tend ultimately to approach the condition of the constituent chemical elements of which the complex bodies were originally composed.

The agents which produce these changes are widely disseminated in nature and make up that large class of substances known as ferments. One of the most characteristic properties of ferments is the power to initiate or institute chemical changes in other substances without suffering to any extent a coincident change themselves. In this respect their action has been likened to that of certain chemical compounds by whoses reactions a new body is formed while one of the original substances which takes part in the action is constantly broken down and as constantly reproduced. Changes of this character are known to chemists as contact or catalytic activities. Owing to this property a small amount of the active substance may give rise to a large amount of the product with out being appreciably consumed or used up.

It has already been stated that the primary causes of all fermentive processes are possessed of life. This is a most important fact from the scientific standpoint, as all living things must, by virtue of their animate nature, also possess the powers of reproduction and multiplication. Another interesting question also presents itself here, viz: that of a living organism taking part, as such, in purely chemical processes, such as we have seen the changes attendant upon fermentation to be. It was early recognized, however, that the substance which was directly instrumental in causing fermentation was not in all cases itself possessed of life, though it might be that it was elaborated by living organisms. This discovery led to a division or classification of ferments into two groups, which are commonly known as organized and unorganized, the former including those animate species which were supposed to give rise to the fermentive changes as a direct result of their vital activities, while the latter comprehends all inanimate chemical substances which possess this power. As common examples of the first class we may note various species of yeasts and bacteria, while

the ferments concerned in the digestion of foods in the alimentary tract of animals furnish illustrations of the unorganized type.

Though the distinction into organized and unorganized ferments has been of undoubted value in their study, it is, however, only an apparent distinction and does not exist in fact. It has been conclusively shown that the activity of all the ferments of the organized or living form depends upon the elaboration of a soluble compound which is exactly analagous to those products of the animal body which have been cited as examples of the unorganized type; the only difference being that the former is the result of the metabolic activities of a plant cell, while in the latter case an animal cell is concerned. As an illustration of this fact it has been shown that by killing the yeast plant with chloroform in such a manner as to avoid any extensive chemical alteration in the protoplasm of the cells, a soluble product could be obtained which showed all the fermentive properties of the living cells, thus proving that the fermentive agent is not the plant itself but a synthetic product built up within its cells similiar to the ferments elaborated within the cells of the digestive organs. If these conclusions are correct, it follows then that the active agent in all fermentation is in reality an organic chemical compound which is in no case organized in the sense of possessing vitality.

In regard to the functions which they perform and the materials upon which they act ferments are naturally grouped into several types. For example one class is characterized by its action upon the sugars of the disaccharine form, one molecule of which it inverts or changes into two molecules of mono saccharide sugar with the addition of the elements of a molecule of water. Owing to this change in the nature of the sugar which is not so great as to cause it entirely to lose its identity, but by which it is converted into another form of the same substance which shows many of the properties that it formerly possessed, the ferments to which this inversion or change of form is due are known under the head of Inverting Ferments.

Another class of ferments of wide distribution and importance is that concerned with the change of starch into

sugar. Familiar examples of this class are to be found in the ptyalin of the saliva which acts upon the starchy constituents of the food changing them first into dextrin and then into sugar, also in germinating seeds where the starch of the seed is converted into sugar so that it may be carried in solution in the sap to subserve the needs of the growing seedling. In the process of brewing the starch of the grain is partly or wholly converted into sugar in a similar way by allowing the grain to germinate when the sprouts are killed by heating and the sugar which is soluble may be extracted and subjected to alcoholic fermentation. This change of starch into sugar like that of inversion is also accompanied by the addition of the elements of a molecule of water and for this reason both are examples of that class of chemical activities known as hydrolysis which means the taking up of water. Ferments acting upon starch in this way are called Diastatic from the word diastase which refers to a ferment which is extracted from germinating grain in the form of a white amorpous powder.

A ferment of a different type whose office is also to convert starch into sugar is found in the pancreatic juice which plays such an important part in the digestion of our food. Its office is supposed to be the changing to sugar of all starchy bodies which were not completely converted by the action of the ptyalin of the saliva. It is thought by many to act differently from the latter, however, in that the starch is converted directly into sugar without passing through the intermediate stage of dextrin. Ferments of this class are also found in the cells of plants, a tropical plant the papaw furnishing one of great potency, known as papain. Substances which act upon starch in this way are known as Amylolytic ferments from the Greek word *amylon* meaning starch.

Another class of ferments which is elaborated by both animal and plant cells, especially by many species of that lower order of plants known as bacteria, is concerned in the destruction of the class of complex nitrogenous bodies called proteids. A familiar example of this class is also found in the trypsin of the pancreatic juice, which acts upon the proteids of the food, causing them to undergo a series of changes by which they are

split up into peptones and other substances which are readily soluble and therefore available as nourishment. It is found that the changes by which many bacteria liquify gelatine, which is a form of proteid, and reduce it to a soluble form, is very similar if not entirely analogous to that which it undergoes when acted upon by the digestive fluids of the animal body. A good illustration of fermentation of this kind occurs in the decomposition of animal remains, which always takes place when materials of this kind contain organisms that possess the power of producing ferments which act upon proteid bodies. Changes of this character are usually attended by the production of disagreeable odors, owing to the presence of nitrogen, sulphur or phosphorus in the substance, and inasmuch as these substances are usually proteid bodies, the agents which induce this change are called Proteolytic ferments.

The activities produced by the ferments of this type are commonly known as putrefaction or decomposition, whereas the changes brought about by other ferments are called true fermentation. This distinction relates wholly to the nature of the substances acted upon and not to any essential difference in the process In fact, putrefaction is best defined as putrid fermentation, and it differs from true fermentation primarily by the fact that in the former the proteid molecule is concerned, while in the latter case the substances concerned are carbo-hydrates and fats. This causes a corresponding difference in the end products of the reaction, those arising from putrefaction containing sulphuretted and phosphoretted hydrogen and ammonia, which are largely responsible for the bad odors, while with the carbo-hydrates and fats the principal end products are carbon dioxide and water if the process is carried to completion.

We find that the last class of food principles, the fats, are also subject to fermentations of various natures. In the process of digestion they, like the starches and proteids, are acted upon by a ferment of the pancreatic juice, and as a result of this action they split up into glycein, a form of alcohol, and various kinds of fatty acids. Fats suffer similar changes when reduced by many bacteria, as well as various other changes depending upon the species of organism at work; one germ, for

example, known as *Bacillus butyricus*, has the power of acting upon the fat of butter with the production of butyric acid, which causes the butter to have a rancid odor. Ferments possessing the power of thus changing fats are classified by some writers as Steatolytic or fat-splitting ferments.

In addition to the general classes of ferments already mentioned many others are known which are of great importance in many ways owing to the character of the changes which they establish or the substances produced. The common splitting of sugar when in solution at the proper temperature, into alcohol and carbonic acid gas is a matter of practical consideration in the production of alcohol and alcoholic drinks and in various other ways. The further change of the alcohol by a process of oxidation brought about by ferments into acetic or other organic acids is often of great value as furnishing the commercial sources of these substances. The coagulation of the casine of milk by the rennet of the stomach or by coagulating ferments produced by bacteria as well as the ferment changes associated with the production of plant food in the soil are all examples of interesting types of fermentation, the number of which might be greatly extended.

Since the discovery of the fact that the fermentations produced by yeasts and bacteria are due to soluble chemical products of their cells, known as enzymes, a great amount of work has been done along the line of isolating these bodies in a pure state and studying their chemical and physiological properties. The importance of the results already established as well as those to be hoped from present and future researches in this direction can scarcely be over estimated. Not among the least to be considered in this regard are those which are of especial interest to the medical profession, as being associated with the prevention and cure of infectious diseases. It may be interesting in this connection to note as an example some recent work done by Dr. Löw and others, upon the enzymes of certain bacteria. It has long been known that an organism usually concerned in the process of suppuration, and called *Bacillus pyocyaneus*, possessed the powers of protecting animals from the very fatal disease of Anthrax, or Splenic Fever, and even of saving them after the

disease had been established, if injected in sufficiently large amounts. Dr. Löw and others, concluding that this protecting power was due not to the mere presence of the second germ, but to some chemical product of its growth, succeeded in isolating from pure cultures of *Bacillus pyocyaneus* a most powerful enzyme or ferment which seemed to possess all the specific actions of the germ, saving animals which had been inoculated with several times the lethal dose of Anthrax, while all the control animals, some of which received a much smaller dose, died in a few days. Dr. Löw also concludes, as a result of his experiments, that this enzyme possesses a specific action against the poison of the germ of Diphtheria, and that it may be found useful as a remedial agent in this disease.

Many other illustrations might be given of the importance of other forms of fermentation and their influence upon almost every condition of human welfare; but enough has been said to cause us to consider this important field of investigation in its true light as one of the most productive of significant results of any that is engaging the attention of the scientist of to-day.

UNIVERSITY OF ILLINOIS.

REGISTRATION.

'87–8	377
'88–9	429
'89–90	469
'90–91	510
'91–2	583
'92–3	714
'93–4	743
'94–5	810
'95–6	855
'96–7	1075
'97–8	1585
'98–9	1824
'99–00	2250

MECHANICS OF THE FARM.

F. R. Crane, B.S., Assistant in Farm Mechanics.

There is no line of work which appeals more strongly or directly to the average boy on the farm than the application of mechanical principles which he unconsciously encounters.

As to reading matter, we find very little, from the farmer's point of view, on this work. Columella, a great agricultural writer of the first century, and who owned a large farm, published twelve books on agriculture, in which he states that the Romans had all kinds of plows, both with and without wheels. Most of his writings along this line are general. At that time he acknowledged that the farm machinery was in a very primitive state. It is within the last generation that farm machinery has taken its present nearly perfect form. One does not need to have passed into middle age to be able to look back on the time of the wooden mould-board, and to remember the song of the harvesters as they laid the grain in the swath. There is no doubt that we are justified in calling the agriculture of 50 years ago the agriculture of the ancients.

Modern drainage systems are the result of the past 50 years of experimental work, and it was not until 10 years ago that tile factories stopped the manufacture of the horseshoe tile. Even at present there are thousands of farmers who have yet to see that, by surface drainage, they are losing the fertility of the soil. They fail to realize that, by allowing the water to pass down through the soil and into the underground tile drains, they carry fertility to the plant roots and keep the soil in a warm, moist, porous condition down to the level of the tile.

This is an age of improvement, and the routine farmer of the past is now meeting the changed condition of affairs with an aggressive spirit. He is looking towards improved machinery and to a bettering of the environments of his home and his crops. These developments are making themselves felt, and farmers

are demanding of their state universities that a place be supplied where the young men can study these mechanical principles, both in theory and practice; for theory is never acceptable unless backed by well established fact. Illinois University is the first in the United States to offer a course in Farm Mechanics. That it is fully appreciated is shown by the fact that during the present semester the students have spent in this study much more time than was required.

Farm Mechanics is a study of the tools, machinery, drainage, fences and buildings of the farm. Especial attention is given to selection, efficiency, proper care and management of farm machinery; considerable time is devoted to testing different powers and generators, capacity of feed grinders and corn shellers, draft of narrow and wide tire wagons, and a careful consideration is given to farm machinery of all kinds. A prominent feature of the work is the study of the laying out, leveling, construction, cost, efficiency and care of farm drainage systems. The instruction consists of lectures and practical demonstration in the field, each student being required to perform all the operations from laying out and leveling to filling the ditch. A portion of the time is devoted to examination of the best kinds of fences for general and specific purposes, their cost, durability, efficiency and care. Farm buildings are considered as to location, construction, strength of materials, capacity and cost, including the drafting by the students of plans of buildings in detail.

The use and abuse of farm machinery should receive the careful attention of every farmer. A machine if it is worth having on the farm, will be found a paying investment when properly cared for. It is a medium for transmitting power; as a labor saving device it allows us to do away, in a large measure, with irresponsible farm hands. But one point must be borne in mind, that, as a machine increases its field of work, in just such a proportion it increases in complexity and demands greater care in using. A machine should be cared for as if it were a favorite animal, and when not in use should be left with something other than the blue sky for a cover and the wind and rain as comforters. It is indeed poor economy for a farmer to buy a binder

or some other expensive machine on credit and then allow it to stand out of doors until the weather completes its destruction. A binder or mowing machine with ordinary care should last from ten to fourteen years, and with extra care will go through twenty seasons of service. But as a matter of fact the average life of the ordinary machine is four to five years, and the implement companies send every year, to their agents, the names of farmers, in their locality, who have purchased machines four years previous, as prospective buyers of new machines. When the fact is considered that Illinois expends over $10,000,000 yearly on farm machinery we are compelled to admit that our people are careless almost to a point of criminal negligence. The loss occasioned by the improper care of farm machinery, buildings, etc., is making itself felt and if a farmer would prosper he can ill afford to neglect them. This is only a fractional part of what might be said along this line, and the special cases cited are but a few of many such which are seen on every side.

The endeavor is to train our young men along these lines, giving them instruction which shall make them familiar with the different tools and machines used on the farm, and with all principles which apply to the condition surrounding them. The vital importance of this work cannot be doubted and the student in Farm Mechanics is looked to as a means, which shall save for our state alone thousands of dollars yearly.

Experiments at the University of Illinois indicate that the system of corn cultivation which will give the highest yield under ordinary conditions is about as follows: Cultivate deep during the early part of the season to remove weeds, conserve moisture and allow the plant an early vigorous development. Then gradually decrease the depth as the corn grows, until near the end of the season when the cultivation should be shallow, and as far from the hill as is consistent with removing weeds, in order to avoid root pruning and to leave the soil in the best mechanical condition.

PRINCIPLES OF CREAM RIPENING.

By Oscar Erf, B.S., Instructor in Dairy Husbandry.

The all-important question of the day with creamery and dairymen is how to obtain a uniform and finely flavored butter. Nearly all investigators agree that the secret lies in the proper ripening of the cream; and when we read of the tons of low grade butter brought into the markets daily, all owing to the fact that negligence or ignorance as to the proper treatment of cream lies at the root of this great fault, it appears to be a point worthy of consideration.

The ripening of cream includes two features upon which the quality of butter largely depends. These are flavor and texture. The effects of ripening are far more marked upon the flavor of the butter than upon the texture, for it is during this process that the characteristic flavors are developed. Cream-ripening is merely a fermentation process, caused by bacterial growth. This growth is controlled by temperature, in which a rise (from 60° F., and not to exceed 100° F.) induces growth and develops immense numbers of bacteria; while lowering of the temperature retards growth. The action of these germs in cream results in the conversion of a part of the milk sugar into lactic acid, and a slight formation of carbonic acid gas and a few other volatile constituents not definitely known.

The production of lactic acid causes the sourness of cream and is largely accountable for the desired flavor in butter. It is the most important product formed, and serves as a guide in testing the ripeness of cream. The carbonic acid gas is mostly given off, but the volatile constituents play an important part, if the ripening be properly carried on, in producing a fine aroma, which is not obtained when foreign acids are added to sweet cream in the attempt to secure the same flavor without ripening. For this reason sweet cream butter has very little flavor, and it

is only through the ripening or souring of cream that the flavor of butter is obtained.

The ripening of cream may develop good or bad flavors depending upon the kinds of bacteria which take part in the fermentation. A particular kind of bacteria, as a rule, gives rise to a fermentation characteristic of that species and consequently the fermentations that give rise to a bad flavor are always due to some undesirable germs that have gained access to the milk. The source of these last named germs in the milk is filth, due to careless and dirty milking or to the use of unclean utensils, or sometimes to the use of milk from a diseased cow. Filthiness is the great source of trouble in the art of butter making and so much stress must be laid on cleanliness in every phase of milk and butter production.

Besides bad fermentations, there is another cause of poorly flavored butter. This comes from cream or milk having been exposed to foul odors, which are absorbed and given to the butter. The theory that milk does not absorb odors when warm and cooling has long been abandoned. Experiments show that milk in that condition is even more susceptible to odors than in any other state. In the ripening process this odor can be partly eliminated by aëration or by pasturization of the cream, but in case of a bad fermentation some antagonistic germ must be added in order to check the progress of the undesirable one.

This antagonistic fermentation is commonly known as a starter, and if properly prepared contains the right kind of flavor-producing bacteria. The preparation of a starter is as follows: Select three or four pint jars of the best milk that comes to the creamery, or, where opportunity affords, select the milk from several good cows; cover these jars and set them away in a warm place until the milk has coagulated. From these select the one that has developed the best sharp, acid taste, free from disagreeable odors and gas bubbles and that shows a solid curd. A can of skim milk should then be heated to a temperature not exceeding 157° F. for twenty minutes and cooled to 75° or 80° F. The selected jar of milk is then added, and after thoroughly mixing, the can is set in a place where the temperature can be kept at 75° or 80° F. for twenty-four hours. A

wooden tank large enough to hold seven or eight times the amount of water occupied by the starter can, answers the purpose well for keeping this starter at a uniform temperature for a long time. The entire amount of the starter should be sour at the end of this period and apparently of the same flavor as that of the original, selected jar. The starter is now ready for use, and an amount equal to seven or eight per cent. of the cream to be ripened is added. By adding one or two quarts daily to fresh pasturized milk it can be perpetuated to the extent of eight to ten days, depending on the cleanliness and the care taken in pasturizing the skim milk.

This method for preparing a starter generally brings the best result; there are however some prepared cultures on the market which are equally as good but more expensive. Simple methods for preparing starters are often proposed, such as leaving some sour cream in the vat and running the fresh cream with it, or by adding buttermilk to the cream; but they cannot be recommended as they too often fail in producing the desired flavor. A starter must not only be considered as a means for improving the flavor of tainted cream, but ought to be adopted universally as a means for ripening all cream. A good starter lays the foundation for fine and uniformly flavored butter, and without it a fine flavor cannot be obtained in pasturized butter The reputation attributed to the Danish people for making uniform butter that has gained preference in the English and other foreign markets is largely if not entirely, due to the use of starters in its manufacture.

In ripening cream, care must be taken to reach the right degree of acidity. This can be determined with Mann's acid test or with the Farrington alkaline tablets. If the ripening is carried on too far the bacteria are apt to attack the albumen, or the fat, of the cream, forming a new product which will give butter a disagreeable flavor. The over-ripening of cream also affects to a large extent the keeping quality of butter. An experiment will probably best illustrate this point. Samples of butter were analyzed. In the first sample the butter churned from over-ripe cream contained 1.16 per cent of casein, while in the second sample butter being churned from mildly ripened

cream contained only 0.8 per cent. As the keeping quality of butter is decreased when its proportion of casein is increased, it will readily be seen that under equal conditions the over-ripe sample would become "off-flavored" more rapidly than the other.

To produce a uniform flavor in butter the degree of acidity must be considered in relation to the thickness of the cream. In the making of a high flavored butter, the cream must be thin rather than thick, in order to furnish more milk serum for the development of more acid. Thick cream should not be ripened to so high a degree of acidity as thin cream, for the reason that the flavor of the butter is endangered on account of the lack of food supply for germ growth for the production of more acid. The following standard has been adopted by many butter-makers as a guide: For cream containing 20 per cent of butter fat, ripening should proceed until about 0.67 per cent of acid develops, as determined by means of Farrington's tablets; and for every 10 per cent increase of fat in cream there should be a decrease of one-tenth of one per cent of acid, as the proper stage for checking the fermentation.

A certain temperature for ripening cream seems to have little effect on the flavor, provided the cream is ripened above 60° and below 90°. The ripening is, however, much hastened by high temperature. A satisfactory temperature is from 65° to 70° for summer and from 70° to 80° in winter. The cream should be stirred occasionally during the ripening process. This is essential for several reasons. It aërates the cream, insures evenness in ripening, prevents the surface from drying,—which is one of the causes of mottled butter,—and furnishes free oxygen to aërobic germs, which seem to play a part in the ripening process.

The texture of butter is largely controlled by temperature, and care must be taken after the flavor has developed, that the cream is cooled a few hours before churning; at about 48° F. for rich cream and 56° F. for thin cream prove to be satisfactory for the average conditions. This, however, depends somewhat upon the temperature of the churn room.

THE GYPSY MOTH IN MASSACHUSETTS.

By A. F. Burgess, M. S., Assistant in Entomclogy.

It is a well known fact that the agriculture and horticultural interests of this country suffer enormous loss annually from insect pests, and even a hasty glance at the statistics on this subject shows that the problem of properly controlling or stamping out injurious insects as they appear is one of no mean importance. Farmers and fruit growers must not only understand how to apply the best remedies to protect their crops from the old and well known pests, but it is necessary for them to become acquainted with the new forms which are constantly being introduced, in order to secure a profitable return for their invested capital. Insects belonging to the latter class are likely to be overlooked and as a rule they prove more injurious than our native species. This is because their natural enemies which, in a measure, hold them in check in their native home have usually been left behind, and thus the pests are enabled to increase practically unchecked.

The loss occasioned by the San José scale has already been the subject of much consideration, and many states have been forced to pass strict inspection laws as a means of protecting their citizens against infested nursery stock. Perhaps no state has had a more unfortunate experience with a single insect pest than Massachusetts, owing to the importation of the Gypsy Moth from France. The state has already spent over one million dollars towards securing the extermination of this insect, and as its possible escape to other regions would cause enormous damage to the agricultural interests of the whole country, we will give a very brief account of its history, the damage which it causes and the measures now being employed by the authorities to stamp out the pest.

The Gypsy Moth is one of the worst insect pests of Europe. It occurs throughout the continent and extends eastward to

China and Japan; it has also been found in northern Africa. The history of its ravages dates back to the first records of insect pests in Europe and more or less serious outbreaks have occurred at frequent intervals down to the present time. This insect is in a great measure responsible for the passage of laws in France requiring property owners to rid their premises of injurious insects under penality of a fine or imprisonment. An instance is on record in southern Russia when in 1879 the Gypsy Moth multiplied to such an extent that the caterpillars stripped the foliage from the forests over an area equal to that of our entire Atlantic states. The larvae feed not only on deciduous and coniferous trees, appearing to show but slight preference as to the species attacked. but when pressed by hunger they eat grass and garden crops; in fact it is a comparatively easy matter to list the plants which they do not attack.

They hatch in the early spring from clusters of eggs deposited by the female moths during the previous summer and after feeding from six to eight weeks pass into the dormant or pupa state. About a week later the moths emerge. The female has a stout body and white wings with black veins; the male is much smaller, dark brown in color, and has a very slender body. Neither sex takes food in this stage and owing to the size and weight of the body the female is unable to fly. This tends to check the rapid spread of the insect. After mating the female lays a cluster of about five hundred eggs, which she covers with hair plucked from her body. These eggs remain upon the tree or rock where they are deposited until the following spring before hatching

Having in mind the bad reputation which this insect possessed in Europe, its wide range of food plants, and its enormous powers of reproduction one would naturally inquire why so destructive a pest was permitted to be brough to this country. It should be stated however that even at the present time no national legislation bars the introduction of injurious insects and although some states have passed quarantine regulations after profiting by sad experience, still there are many where none now exist.

In the year 1869, several egg clusters of the Gypsy Moth

were received at Medford, Massachusetts, a city about three miles from Boston, by Mr. Leopold Trouvelot, a French naturalist and astronomer. At this time he was conducting a series of experiments with the silk worm and some of our native silk spinning moths, and it was with a view to interbreeding that the Gypsy Moth was introduced. Some of the young caterpillars accidentally escaped from captivity and spread from the premises of Mr. Trouvelot to the land adjoining, a part of which, at this time, was covered with a growth of young trees. For the next fifteen years little trouble was experienced from the insect, chiefly because this brush land was usually burned over annually. It was also frequented in the summer by many insectivorous birds.

As the years went by, however, and this portion of the city became more thickly settled the residents began to be troubled by hoards of caterpillars which appeared every spring and defoliated the fruit and shade trees. Each succeeding year the insects seemed to come in greater numbers and in spite of the efforts of the inhabitants, the trees were denuded of their leaves. They came in such hosts that the fences and tree trunks appeared like one living mass of caterpillars, the houses were invaded, and it was not uncommon to find them in the pantry or in the bedding, although the utmost care was taken to prevent their entrance. Thousands crawled on the side walks and were crushed beneath the feet of the passers-by. The people swept the squirming larvae into piles, applied kerosene and burned them. Even this treatment seemed to have little effect in decreasing their numbers or diminishing the damage. The "worm" or the "caterpillar," as this insect was called by the people, continued to appear in overwhelming numbers each year and many dead and dying trees showed the effects of their ravages. The situation at last became so bad, that in 1889 the city of Medford made an appropriation of $300 to be expended in protecting the city shade trees. Some effective work was done, but it was found that the insect had spread to such an extent that the appropriation was exhausted before any considerable area could be treated.

At about this time the true nature of the pest was discov-

ered, specimens having been sent to Dr. C. H. Fernald, and in his absence determined by Mrs. Fernald as the Gypsy Moth of Europe. A bulletin was issued by Dr. Fernald from the Massachusetts Agricultural Experiment Station describing the pest and recommending the best known methods of fighting it, copies of which were mailed to the inhabitants of the infested district.

It was soon found that the moth was present in the cities and towns adjoining Medford, and on seeing the amount of damage that was being done and the inability of the private citizen or the municipality to cope with the pest, on account of its wide distribution, the limited knowledge of its habits and the proper methods to be used in subduing it, many urgent petitions were sent to the legislature requesting that the state take charge of the work. A law was passed creating a commission of three men. It specified that they should use all reasonable means to prevent the spread and secure the extermination of the Gypsy Moth, and $25,000 was appropriated for the purpose. The commissioners or their agents were empowered to enter upon any or all lands within the commonwealth where the moth was supposed to exist and in case it was found, to do what work they considered necessary to secure the extermination of the pest. In the event of damage being done to the property, the owner would be allowed a certain compensation, which was provided for in another section of the act. The law also made the carrying of the Gypsy Moth in any form from one town to another within the state an offence punishable by a fine or imprisonment.

The commission immediately set to work and considerable progress was made before the end of the year. A great portion of the territory then known to be infested was in the thickly settled suburbs of Boston and it was necessary to pay particular attention to the worst infested places in order to prevent the insect from spreading to the sparsely populated districts and the forests. As the females do not fly the only way in which the insects are spread to any considerable distance is by the caterpillars being carried on teams, trolley cars or other moving objects. Many colonies have been started in this way, and the danger is increased by the habit of the caterpillars of spinning

fine silken threads and lowering themselves from the trees on which they are feeding to objects beneath.

The following year the work was placed under a committee consisting of five members of the State Board of Agriculture, who received no pay except their actual traveling expenses. This committee at once called together many experts, among whom were the late Dr. C. V. Riley, who was then Entomologist to the U. S. Department of Agriculture and Dr. Fernald, Entomologist to the Massachusetts Agriculture Experiment Station, for the purpose of inspecting the infested region and devising some practical scheme for destroying the insect.

It was decided to adopt the methods then in successful use against injurious insects in general, with such modifications as experience should show would be practicable and, as a basis for future work, to establish the outer line of infestation by inspecting suspected towns At the end of the year the inspection showed that the moth had been found in greater or less numbers in thirty cities and towns, comprising an area of about 220 square miles. The northern and southern limits were Beverly and Boston respectively; from these boundaries the line of infestation extended westward several tiers of towns; the eastern boundary being formed by the ocean. Not all of this area was badly infested, in some towns only a few small colonies or infested spots being present. A feasible plan, which has been followed by the committee, is to reduce the moth in the central and worst infested district, at the same time inspecting and treating in the most careful manner the outer colonies so that the number of infested towns on the outside border may be diminished and in this way the insect crushed out.

Judging from their reports, the Gypsy Moth Committee soon became convinced of two facts: First, that the insect could be exterminated, and second, that the legislature could not be depended upon to make prompt and sufficient appropriations. This failure has at times handicapped the work, and is responsible for many woodland colonies which have been found flourishing in towns where the work had to be left undone for want of sufficient funds. In spite of this, the work has been systematized, the men trained for their special duties and many colo-

nies have been exterminated which were located in most unfavorable localities for effective work.

Experimental investigations have been conducted which have formed the basis for the methods used on a large scale by the field force, and every line of action promising good results has been thoroughly tested. The life history and habits of the moth, its natural enemies and parasites have been carefully studied, and in addition many insecticides have been devised and tested by Dr. Fernald, the entomologist to the committee, and his assistants. Mr. Forbush, the director of field work, has given much time to the study of the influence of birds upon the increase of the Gypsy Moth, and his assistants have made many needed improvements in spraying machinery. The details of these researches cannot be discussed in this brief paper; suffice it to say that many of the discoveries were new to science and will have wide influence in the future treatment of injurious insects. It should be stated, however, that numerous birds and insects of predatory habits have been found to feed upon the Gypsy Moth larvae. A few insect parasites have also been reared, but the effects of these enemies have been insignificant, thus far, in checking the increase of the moth. From consulting the European literature and corresponding with many foreign entomologists, Dr. Fernald has learned that the Gypsy Moth has no specific parasite in its native home, although a combination of natural enemies serves to diminish its numbers. As this is the case, little benefit would be likely to result from the introduction of foreign parasites or natural enemies.

It was found by experience that many of the measures heretofore employed against leaf-eating insects were entirely impractical when applied against the Gypsy Moth. The common method of banding the trees with printer's ink was tried to prevent the insects from ascending, but the Gypsy larvae swarmed up the trunks in such numbers as to actually make living bridges, over which their comrades would ascend and devour the foliage. One of the best methods found for ridding the trees of these caterpillars was discovered in connection with a peculiar habit which they possess. After becoming half grown they feed at night and descend the trees in search of shelter

during the daytime. In order to furnish an artificial hiding place the trees are encircled with a band of coarsely woven sacking about ten inches in width. This is held in place by a string tied around the middle, the upper part of the band or burlap then being folded down. These bands are examined regularly and the caterpillars killed. The absence of the Gypsy Moth in many localities is a silent witness to the efficacy of this method.

Until the war against this insect begun, spraying with Paris green was considered the panacea for all leaf-eating insects. Experience showed that after these caterpillars became half grown the application of this spray in a strength which would not injure the foliage failed to kill them. Experiments were at once commenced to devise some effectual poison. Hundreds of new substances were tried, with no satisfactory result until arsenate of lead was discovered. It was found that by using this poison nearly all the larvae could be killed, and without the slightest injury to the foliage. So successful has this substance proved as an insecticide that many entomologists have already recommended its use against all leaf-eating insects.

In wood and brush land which is swarming with caterpillars it is the practice to spray the ground and low growth with burning crude oil. This method is also used in burning out stone walls, where larvae have crawled previous to pupating, and in many localities it has proved invaluable.

The winter work consists chiefly in inspecting the infested territory and searching out and treating the egg clusters with creosote oil and clearing infested land of diseased and worthless trees, which serve as breeding places for the moth. The oil kills the eggs and prevents any chance of their being scattered as would be the case if they were removed from the place of deposition. This has proved very effectual when supplemented by burlapping the trees in the spring. Owing to the great variety of topographical situations in which the insect is found it is usually practical to employ a combination of methods and it is always necessary to continue the work of inspecting the trees for several years after the last caterpillar has been found in order to prevent any stragglers from being left behind.

An inspection of the work will readily convince one that the most economical way to fight this insect is to destroy as many of the egg clusters as possible before the larvae hatch. Unfortunately the Legislature convenes in January each year and the appropriation for this work is often not made available before the middle of April. By this time the larvae are hatching and several months, when the most effective work could have been done, are lost. The presence of many woodland colonies is a direct result of this hesitating policy and the committee state that several colonies which have been discovered outside of the line drawn in 1891 are accounted for chiefly because of diminished and tardy appropriations. One of these infested places comprised something over two acres of forest which on being discoverd was promptly treated in the following manner: About fifteen acres, including the infested portion, were cut and burned in the fall, but during the following spring scattering caterpillars were found around the border. Fire was applied to the surrounding area and no traces of the moth have been found since.

The committee has always encountered more or less opposition in obtaining funds from the state. This arises chiefly from individuals who have some personal grievance which is usually more imagined than real, or from those who are little acquainted with the work and have formed hasty opinions without fully investigating. The latter are positive in their conviction that the extermination of the insect is impossible and that the money is not being wisely spent. The committee has always welcomed the investigation of the work by citizens or experts, and to the latter end have frequently invited official entomologists to inspect their methods in the hope that suggestions for improvement might be received and any existing defects remedied. Many of these invitations have been accepted and the signed statements of leading entomologists bear witness to their appreciation of the magnitude, importance and efficiency of the work. The fact that no economic entomologist of recognized standing, has, after carefully inspecting the work, expressed the opinion that the insect could not be exterminated, argues well for the ultimate success of the undertaking. The American

Association of Economic Entomologists, composed chiefly of the official economic entomologists of the United States have at each of the last four annual meetings passed resolutions heartily endorsing the Gypsy Moth work. Each year these resolutions have expressed the belief that the insect could be ultimately extirpated provided the funds were promptly furnished the committee, and have affirmed that the discontinuance of the work would be a national calamity.

In 1897, Dr. L. O. Howard, Entomologist to the United States Department of Agriculture, by direction of the Secretary of Agriculture made a detailed inspection of the work. The results of his observations have already been published.* He states positively his belief that the insect can be exterminated, provided the necessary funds are furnished the committee, and urges that the work be continued and the result accomplished.

The present condition of the Gypsy Moth work may be summed up in the following manner. During the past ten years the committee have demonstrated that it is both possible and practical to exterminate the pest and they have succeeded in so far reducing the infested area that the work at present consists more in carefully inspecting the towns where the insect has been found then in actually applying exterminative measures. To perform this work a large force of experienced men is absolutely necessary, hence liberal appropriations of money will be required for a few years.

Many citizens feel that in exterminating the Gypsy Moth the State of Massachusetts is incidentally protecting every other state in the Union, and that if the work is to continue the United States Government should assist in the undertaking. Few will question the soundness of this argument. The insect should be stamped out with all possible speed, as its presence is most pernicious, and if left unchecked it will, in a few years, cause enormous damage to the agricultural and forestry interests of the country.

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*The Gypsy Moth of America. Bulletin 11, New Series, Division of En omology, U. S. Department of Agriculture.

CHICAGO AS A LIVE STOCK MARKET.

By J. E. Raymond, B. S., Class of 1899.

Whether a live stock breeder is engaged in the production of pure bred breeding animals or in the production of animals destined for slaughter, his interest is much the same in disposing of his product to the best possible advantage. When the feeder has brought his animals into the best market condition, that is, when gains made, cease to make profitable returns on the feeding ration, he comes to consider which of the so-called "great" markets offers the best advantages for the profitable disposal of his product. Of late years the producers of pure bred breeding animals have originated the custom of disposing of their highly bred product at public sales or auctions in the principal regular live stock markets. The recent combination sales of Hereford and Angus cattle at Kansas City and Chicago respectively may be cited as instances of the above.

Now comes the question—which is best of the great western markets for the live stock breeders and feeders of the central western states and especially of Illinois?

In taking up this subject from the feeder's point of view I desire first to submit a graphic table designed to show the dimensions and distribution of the live stock trade at the six principal market points for the year 1898.

This table, compiled from official reports, shows that Chicago received in 1898 1,929,923 more cattle than St. Louis; 1,801,386 more cattle than Omaha, and 767,397 more cattle than Kansas City; while Chicago slaughtered nearly as many cattle as Kansas City, Omaha, and St. Louis together. This shows that Chicago is the market of final destination for a large portion of the cattle received and sold at other markets. The leading Eastern slaughterers and the great Western packers alike find Chicago their chief base of supplies for live hogs. No where else can they always find, in large quantities, just the right

RECEIPTS.

Market.	Per cent.	Head
Cattle—		
Chicago	40.3	2,613,630
Kansas City	28.5	1,846,233
Omaha	12.5	812,244
St. Louis	10.5	683,707
Sioux City	4.6	300,937
St. Joseph	3.6	232,078
Hogs—		
Chicago	51.0	9,357,114
Kansas City	20.0	3,672,909
Omaha	11.4	2,101,387
St. Louis	9.4	1,728,320
St. Joseph	5.6	1,034,125
Sioux City	2.6	474,238
Sheep—		
Chicago	57.6	3,589,439
Omaha	17.4	1,085,136
Kansas City	15.7	980,303
St. Louis	7.0	435,893
St. Joseph	2.0	121,407
Sioux City	.3	20,861

SLAUGHTER.

Cattle—		
Chicago	45.9	1,720,144
Kansas City	24.3	910,731
St. Louis	12.9	484,269
Omaha	12.2	458,585
St. Joseph	4.1	152,665
Sioux City	.6	23,380
Hogs—		
Chicago	50.8	8,016,570
Kansas City	20.9	3,299,680
Omaha	12.2	1,928,250
St. Louis	7.8	1,227,107
St. Joseph	5.9	930,083
Sioux City	2.4	388,273
Sheep—		
Chicago	65.3	3,046,014
Kansas City	13.4	624,759
Omaha	12.2	572,148
St. Louis	6.9	322,560
St. Joseph	2.0	91,952
Sioux City	.2	8,834

kind of hogs to suit their demands. Their constant competition with each other in buying keeps up a healthy state of the market at all times, and the prices established at the Chicago market govern all others. The number of sheep slaughtered at Chicago in 1898 was more than double the number at Omaha, Kansas City and St. Louis combined.

In short, although Chicago is far ahead as a market, her prestige as a live market, as shown by the table, is far exceeded by her importance as a slaughtering point; and this of course has great influence on the prosperity of the market. Since Chicago is so far in advance of other markets we will pass to a somewhat complete consideration of her resources and interesting development.

The Civil War, from '61 to '65, massing two million men in the field, called for a food supply never before met, nor even thought of in this country. The first city in the Union to grasp the situation, and be ready to meet it, was Chicago. This city in the heart of a section that had responded quickly and generously to the government's call for troops, lost no time in beginning the essential work of feeding the soldiers at the front. The inventive genius of Chicago devised many practical ways for converting cereals, meats and other products into forms suitable for transportation and preservation; and industries were established that called upon the great agricultural section of the country for raw products, and laid the foundation in Chicago for other vast manufacturing enterprises.

The second fundamental cause underlying Chicago's greatness in many industries and especially as a live stock market, is to be attributed to the remarkable development of the natural resources of the continent, the rapid building of railways, the opening of factories in every direction, and the greatest activity ever known in mining; all of which followed soon after the Civil War.

The third important reason for Chicago's supremacy is found in the fact that ever since the Civil War this city has been the point where the live stock and other food products of the continent could be concentrated, manufactured and distributed with the greatest economy and dispatch. The origin and growth of our great export trade in live and dressed meats, controlled almost solely by Chicago, is a good example of the above. Chicago is the greatest railroad center of the world. Here is a point from which begin or end more lines of railway, with more mileage, than can be shown by any other city on earth. Not only this, but in Chicago are the central offices; in it are the

constructive and directive forces of not only the leading railways of North America, but also of South America and many distant countries. These Chicago railways, consisting of some twenty-five "systems," have a total mileage of sixty-seven thousand seven hundred. The city of Chicago has, in addition to her railway facilities, the advantages of cheap waterways, afforded by the great lakes and canals. Chicago is the leading port of the world—even ahead of London and New York—in number of vessels entering and clearing port and in tonnage handled. I cite official figures for the year ending June 30, 1898:

	No. Vessels.	Tonnage.
Chicago	19,193	16,649,873
New York	14,445	15,348,042
London	16,320	15,797,659

Competition, the life of trade, gives this lake freight traffic an immense leveling power upon rail transportation. Chicago is located near the center of population of the United States, and has tributary to it the great producing West on the one hand and the great consuming East on the other. On this point the greatest authority on statistics in the world, M. G. Munhall, of England, says that what are known as the Prairie States, viz: Ohio, Michigan, Illinois, Indiana, Iowa, Wisconsin, Minnesota, Missouri, Kansas, Nebraska and the two Dakotas, where farming and stock raising have been carried on together, and from which comes the bulk of the live stock and grain of the United States, had in 1890 in aggregate wealth the fabulous total of $25,256,-000,000. Furthermore, he states that these states have made the greatest gain during the past thirty years in both aggregate wealth and per capita wealth, and that the same ratio of increase holds in population, while in the matter of education it is even greater. He concludes as follows:

"These facts demonstrate that the source of power, as well as the center of population, is moving westward with certain and rapid strides, and that in the near future the Mississippi Valley will be the commercial center of the republic."

Chicago is the commercial heart of the Mississippi Valley, the transportation center of the Prairie States and the center of population of the United States. By reason of its splendid loca-

tion, equi-distant between the fields of production and the great heart of consumption, together with its unrivaled lake and rail transportation facilities, it is at once the natural focus for products of all kinds, and the grand central distributing supply depot of the continent. Hence it is the best market for both producers and consumers; the natural trading point where buyers and sellers meet in greatest number, and is coming to be the greatest manufacturing center of the western hemisphere. The principal cause of Chicago's greatness lies in the fact that she is a city with nearly two million people, the second largest in America, the fourth largest in the world; and so, as a live stock market, she offers the indispensable elements of a large consuming population, and a great number of manufacturing industries that utilize those vast quantities of bye-products of live stock that must be handled locally to insure the most profitable results from the slaughtering of animals. Chicago people alone consume annually over three hundred million pounds of meats, equal to 600,000 head of cattle.

It naturally follows that Chicago not only does immeasurably the largest live stock business, but she even draws thousands of animals from other stock yards. As an example, in 1898 there were forwarded to Chicago from other markets carloads of cattle as follows:

	Cars of Cattle.
From Kansas City stock yards	4,483
From Omaha Union stock yards	1,852
From St. Louis Nat'l stock yards	965
Total cars of cattle	7,300

This total does not include the many cars stopping at the many intermediate markets, and forwarded through to Chicago on original billing without change of ownership. These consignments are made principally by speculators who make a regular business of buying animals on other markets and shipping them to Chicago for sale, and that they find it profitable is evidenced by the fact that they continue successfully and constantly year after year.

Another advantage that Chicago claims is that its prices paid for live stock are better than elsewhere. At Chicago, both the concentration of live animals and the distribution of meats

are accomplished with greatest economy and dispatch; the offal can be handled with the greatest profit, and the local demand for meat is greater than elsewhere. Chicago dealers must meet the competition of eastern slaughterers and exporters always present on the market in large numbers, being attracted by the constant large supply and splendid assortment of meat animals to choose from. For these reasons it is unhesitatingly claimed, and figures are given to prove, that the packers of Chicago can and do pay higher prices to producers for live animals, and furnish consumers with better and cheaper meats and other animal products, than is possible at any point where either producers or consumers are more distant from the point of manufacture, or in fact at any other point in the world.

Ninety-nine has been a banner year for Chicago and receipts and prices have been excellent. During the first eleven months of the year, Chicago, Kansas City, Omaha and St. Louis received 25,014,451 head of cattle, hogs and sheep. Chicago alone has a total of 13,104,692 head. The combined receipts of cattle, hogs and sheep at the Chicago stock yards were 1,394,470 head for November; 335,443 more than the grand total at the other three principal western markets. Chicago received 536,671 more cattle, 2,326,294 more sheep, and 4,692,454 more hogs than has any other market during the eleven months ending Nov. 30, 1899.

The prices at all markets have been especially active the past year, but Chicago has paid the best prices that cattle have brought in many years, and the hog and sheep market has been very satisfactory. Fed Texans at times during the year have brought six dollars and better, good cattle sold strong and during September and October native cattle touched the seven dollar mark. The Christmas cattle market was brilliantly active in fancy lines and the highest prices were reported since the early eighties.

As a market for breeding animals Chicago ranks very high. The stables and sale pavillion at Dexter Park are available and admirably suited to such purposes. Kansas City has been an honorable competitor of Chicago in the line of breeding cattle sales, but the prices brought at the great Angus sale were satis-

factory, (the average some seven dollars above the prices at the Kansas City Hereford show), and proof that Chicago can easily lead in this branch of the trade.

The old time "American Fat Stock Show" for many years held at Chicago, but discontinued of late years, promises to be succeeded by a more active and valuable institution. The first notable move was a conference held during the Illinois State Fair between representatives of the Chicago live stock market and the breeders exhibiting at the Illinois and other state fairs. That meeting was decidedly in favor of the project under proper management, so that another meeting was called at Chicago to be held in November, during the week of the breeders annual national meetings. The great show and sale under the auspices of the American Hereford Association, the action of the Central Shorthorn Breeders' Association, and also the resolutions of the Illinois Live Stock Breeders' Association, seemed to intensify the demand for a national show that would represent all breeds of live stock.

With characteristic enterprise and munificent liberality, Chicago began to shape matters to inaugurate a great annual live stock exposition, to be held at the handsome and commodious new Dexter Park Amphitheater, now nearly completed, and owned by the Chicago Stock Yards Company. This building, together with large cash premiums, was offered to the breeders' associations as an inducement for their coöperation. Acceptance was prompt, and plans were soon formed that assured the success of the International Live Stock Exposition, to be held the first week in December, 1900, at Chicago, under a most competent and public-spirited management. It will be the greatest exposition of live stock and live stock products the world has ever seen, and will be of the highest educational value to breeders, feeders and farmers, as well as the general public.

With this great prospect for 1900, and with 1899 Christmas cattle bringing as high as $8.25 (as did Mr. Kerrick's "doddies" last December), beside the many advantages we have mentioned above, it seems that the farmers of Illinois ought certainly to be satisfied with Chicago as a live stock market.

MILK AND ITS CONSTITUENTS.

By J. A. Latzer, B. S., Class of 1899.

This is a subject that is of interest to every one, for milk is used by most people in one form or another. The exact extent of the dairy industry is not known, but it has been estimated that the milk annually consumed in the U. S. averages 25.5 gallons per person. As stated in Farmer's Bulletin No. 42 dairying exceeds any other industry in this country.

Although milk is such a common product, a few words in description may still be in order. Milk is a whitish, opaque liquid, appearing to the ordinary observer and especially at first thought to be a perfect solution. And being regarded as such, it is usually bought and sold by liquid measure. When milk is closely examined with the aid of high magnifying powers, such as are afforded by our modern microscopes, we find small particles in suspension, i. e., particles not in solution. These particles are fat and are always globular, varying in size, and number in samples of milk from the same cow, but the variation is still greater in milk from different cows. The whiteness or opaqueness of milk is largely due to the fat globules held in suspension. When, however, all or nearly all the fat is removed, there still remains an opaqueness, which is supposed to be due to one of the mineral salts, phosphate of lime, present in very small amounts.

The average composition of milk is generally regarded as: water 87.2%; protein 3.6%; milk sugar 4.9%; fat 3.7%; ash .7%, the ash as here given including all the mineral salts found in milk. The protein is composed of casein 3.1% and albumen 0.5%. The former is the portion of milk that enters largely into the manufacture of cheese, and the latter is frequently noticed on the surface after boiling of milk. The milk sugar is in solution and found in the whey. There are often great variations from the above average composition, so great indeed, that

the above is not everywhere considered as the standard. A number of the states have dairy laws and fix the per cent. of fat, below which milk must not be sold. These laws vary in different states, thus proving again that milk is a very inconstant article. Of the different constituents the fat is most liable to vary, and it will vary more widely than any of the other constituents. It is for this reason that fat is often the only thing taken into consideration in studying the variations in milk.

There are great variations between the first and last milk drawn. This is very evident from the figures obtained at the New York Station, by drawing milk from a cow pint by pint and testing the same for fat. The successive pints tested as follows for per cent. of fat: 0.85; 1.43; 1.68; 2.02; 2.23; 2.65; 3.28; 3.74; 4.05; 4.86; 4.48; 4.30; 5.23. This shows an increase of over 500% in the last over the first.

There is also a difference between old and young cows. Cows generally produce richer milk when young than when old. There is however a very much greater difference in the per cent. of fat in milk from cows of different breeds. For example, a Jersey cow will yield a larger amount of fat, in a given amount of milk, than will a Holstein-Friesian cow. Within the same breed however there are often variations that will surpass many that can be found between different breeds. This is especially true of breeds that are not typical dairy breeds, e. g., between Shorthorn cows.

The first milk or colostrum contains large quantities of proteids amounting in some cases to 15%. Usually more than half of this is albumen, while in normal milk the per cent. of albumen is very small, being only 0.5%. The per cent. of sugar is considerably lower than in other milk but the fat generally remains normal. This milk is fit only for the new born animal, as it acts as a laxative, which is an essential thing soon after the birth of the animal. The milk in a few days becomes normal.

It is generally supposed that the kind of feed greatly affects the constituents of the milk. The idea very prevalent is that when feeding succulent feed the milk produced will be thinner, that is, that the per cent. of solids will decrease. The Ohio legislature has gone so far in making dairy laws as to fix the

requirement for fat 0.5% lower in May and June, than for the rest of the year. Upon what this is based, except general opinion, I have not been able to discover. All experiments that have been conducted tend to show that there is no such change in the per cent. of fat due to different feeds. There are often slight increases or decreases in the per cent. of fat on changing of feed, but it soon settles back to the old standard. It is thought by some, that this change is due to a nervous reaction caused by the change in the feed; because these changes will take place in changing from one feed to another and are not kept up if the same feed is continually used. There are often considerable changes from day to day and they seem to go in periods, these being due to unknown causes. To show that there are such changes in the normal cow I will cite from Illinois Bul. No. 51, page 84. From the evening of the 30th to the morning of the 31st the per cent. of fat increased from 2.7% to 4.0%. The reason for so large a change is not known but the variation is a great deal larger than any that I have noted from change of feed.

We have seen that great variations are found in the milk as it comes from the cow, but they are often produced or enlarged by the aid of the human hand, and this is only too often the case. This is done by the addition of water, by taking away of cream or by the combination of the two. This is especially very tempting when the dairyman knows that the buyer has no means of detecting the addition or subtraction, as the case may be. We have now quite definite and speedy means of detecting these adulterations, viz., by the use of the Babcock test. This certainly tends to diminish the number of cases in which the milk has received its finishing touches at the hands of the dairyman. There are however cases in which the customer's failure to get what he pays for, is due to the ignorance of the dairyman rather than to his willful intent to cheat. This is due to his failure to stir the milk before drawing off at the bottom of the can. At the New York Station it was held that when delivering in a wagon, the shaking of the wagon would be enough to keep the milk well mixed. Having noticed, however, that when milk is delivered in bottles, the cream will seperate in spite of the

jarring of the wagon, I conducted an experiment as follows: An eight-gallon can fitted with a faucet was filled with milk, which was well stirred and a sample taken. The can was then placed in the University delivery wagon and started on the regular route of delivery. The roads were very muddy, and fast driving was impossible. Notwithstanding this, however, there was considerable shaking of the milk. After a half hour's drive a sample was drawn off at the bottom, and a quart every seven or eight minutes thereafter; when three quarts were drawn another sample was taken, and one every half hour thereafter until the seventh sample was obtained. Now all the milk except one pint was drawn. This pint was also tested.

The results are as follows:

No. of sample..................	1	2	3	4	5	6	7	8
Per cent. of fat..................	4.35	3.70	3.20	44.5	4.45	4.35	4.35	4.35

This seems to indicate that as long as the can is full or very nearly so, and not enough room for shaking, the milk will separate. The second and third samples are deficient in fat because it has risen to the top, just as shown in the bottles. After this the per cent. of fat was almost perfectly uniform, and the same as first one taken. No one can doubt that there would have been a greatly increased difference if the can had been placed on the counter instead of in the wagon.

The Babcock method is a speedy and quite accurate one for the determination of fat in milk; but it is sometimes interesting, and often important to know the exact amount of the other constituents, and for this purpose a chemical analysis must be resorted to.

After looking over Circular 13 of our experiment station, and noting the great variations in the milk supplied to the Chicago markets; noting some very high per cents. of fat and some surprisingly low ones, I thought it would be interesting to compare the milk supplied to smaller towns with that of Chicago. So Urbana and Champaign were canvassed and samples of milk procured at random from the different dairymen. It was the aim not to let the dealer know to what use the milk was to be put, in order to get a sample to represent the milk generally sold. Some of the dealers live in town and furnish milk to only

one or two customers. The results of the analysis were as follows:

*Analysis of Champaign Milk.

No. of Sample.	Specific Gravity.	Total Solids per Cent.	Fat per Cent.	Protein per Cent.	Sugar per Cent.	Ash per Cent.
502	1.0326	13.00	3.75	3.25	5.31	.69
503	1.0315	11.35	2.75	3.28	4.60	.72
504	1.0318	11.64	3.50	2.89	4.60	.65
505	1.0334	12.52	——	3.04	— -	.69
507	1.0320	12.08	3.60	2.89	4.97	.62
508	1.0330	12.28	4.10	3.03	4.50	.65
511	1.0310	11.55	3.20	2.85	4.94	.56
513	1.0296	11.84	3.55	2.95	4.71	.63
515	1.0360	13.80	4.07	3.99	5.00	.74
516	1.0294	10.42	3.00	2.75	4.07	.60
Av'r.	1.0320	12.05	3.50	3.59	4.74	.67

Analysis of Urbana Milk.

No. of Sample.	Specific Gravity.	Total Solids per Cent.	Fat per Cent.	Protein per Cent.	Sugar per Cent	Ash per Cent.
500	1.0338	10.89	3.10	3.22	3.72	.85
501	1.0338	10.89	3.25	3.22	3.58	.85
506	1.0293	13.23	——	3.27	——	.57
509	1.0338	13.67	3.85	3.65	5.72	.65
510	1.0337	13.44	4.05	3.60	5.13	.65
512	1.0348	15.33	4.95	4.25	5.39	.74
514	1.0352	15.68	5.00	4.53	5.40	.75
529	1.0330	12.63	4.35	3.21	4.40	.67
530	1.0318	12.65	4.35	3.22	4.43	.63
Av'r	1.0331	13.15	4.11	3.57	4.72	.70

The milk collected in Urbana showed a somewhat higher per cent. of solids and fat than the Champaign milk. The difference is largely due to two samples that tested especially high, and these samples were obtained from a herd consisting of two Jersey cows and supplying one or two customers. The milk from these towns compared favorably with that of Chicago and is far more uniform.

NUTRITIVE VALUE OF MILK.

Milk without a doubt comes nearer being a perfect food than any other, because it contains all the constituents necessary to sustain life; and in nearly the same proportion as required to build up the body. We see therefore that it is admirably suited

*The work of analysis was done in the University, department of Chemistry, as part of regular class work.

as food for children or growing animals, and we know that the earliest stage of life of all animals is sustained upon milk. When however the body has ceased growing, the nutritive ratio, viz., that between protein and carbohydrates is too narrow, in other words there is too high a proportion of protein, and this is both wasteful to the system, and very expensive.

The value of the different food constituents is not the same nor is their purpose the same. The prime object of food is first to build up the body and then furnish energy to support it. Proteids are the constituents which go to build up the body, and after the body ceases to grow, they do the repairing; that is, replace the waste of tissues, which in average life, is very small in amount. Milk is rich in protein, and is for this reason valuable as an infant food. In the full grown person the intake of protein is invariably more than is needed for the repair of the body. It is not so far as known stored up in any part of the body for future use, nor is it wasted, but it goes to the production of energy.* When these proteids are used in any form in the body considerable waste matter is produced, most of which must be gotten rid of through the kidneys; consequently the excess of proteids taken in, i. e., those that go to the production of energy, produce an extra strain on the kidneys, which may in time result in kidney troubles.

Carbohydrates differ from proteids in that they go only to the production of energy, and the excess is stored up in the body, in the liver, in the form of glycogen or over the body in the form of fat. In looking at the composition of carbohydrates closely we find that they are composed of carbon, hydrogen and oxygen, the last two being in the same proportion as in water. Take for example, milk sugar $C_6 H_{12} O_6$; on separation we find carbon and water. When we have oxidation of the milk sugar or burning it, oxygen of the air unites with the carbon, then CO_2 and H_2O are produced. The former is gotten rid of through the lungs, the latter in several ways, viz., through the lungs, skin and kidneys.

The fuel value, or the amount of energy liberated by the

*A full discussion is given in Dr. Foster's Text book of Physiology, 1895 Page 625.

different food constituents has been carefully worked out by different scientists. The fuel value of any food is measured by calories. This is a term used to designate the amount of heat required to raise one kilogram of water one degree Centigrade, or one pound four degrees Fahrenheit. The mechanical energy is generally measured by foot-tons, and one calorie corresponds to 1.53 foot tons.

The following table has been worked out:*

1 gram of carbohydrate equals 4.1 calories or 6.3 foot-tons
1 gram of fat equals 9.3 calories or 14.2 foot-tons
1 gram of protein equals 4.1 calories or 6.3 foot-tons

We see from this, proteids are equal to carbohydrates in the production of heat, and fat is practically 2¼ times as valuable as either of the others for this purpose. It is for this reason that fat is and should be considered as a very important element in the use of milk. Calculating from the above table, we have in 100 grams of milk of average composition 63.16 calories, 32.31 of which are in the fat, i. e., more than one half of the energy is in the fat alone. The 3.6 grams of protein furnish 14.76 calories and the 4.9 grams of carbohydrates 16.09 calories; these two elements and also the mineral matter remain in the skim milk. Thus nearly half the fuel value remains in the skim milk, and its feeding value is comparatively high because of its content of protein.

The farmer in selling the cream to a creamery only sells a very small part of the manurial value of the milk, practically none. All the nitrogen and mineral matter is detained in the skim milk, which serves as food for the calves and pigs. It is for this reason that dairy farming is very easy on land or may even tend to make it richer. There are always more of the mineral salts brought into solution and practically none taken off, and what is taken off is again brought back in the manure, thus making dairying the most economical branch of agriculture, from the standpoint of the fertility of the farm.

*Henry's "Feeds and Feeding."

THE SUGAR BEET INDUSTRY IN ILLINOIS.

By Ross Bartholomew, Assistant Field Superintendent, Illinois Sugar Refining Company.

The sugar beet industry in Illinois, although now in its infancy and confined to a small area, is destined to become one of the leading industries of the state. Unlike many others, this industry must depend for its raw product upon the country within 100 miles of the factory, and usually even a less distance than this; so wherever a factory is built the immediate region is the one benefited. The only factory in this state at present, is located at Pekin and is operated by the Illinois Sugar Refining Company. The factory this year consumed about 3,000 acres of beets. These were grown on different kinds of soil and with various degrees of success. The soils varied from the sandy ones to rich, black loams. Although many facts were demonstrated by this season's work, there is much yet to be learned from experiment before the sugar beet industry will attain its highest agricultural success in Illinois.

The first and most important factor in the culture of the sugar beet is the selection of the soil. It should be rich. As a rule soil which produces good corn raises good beets. If the soil has been subject to a rotation of crops it is so much the better. Clover sod is as good as anything providing it has been plowed in the fall, or else has been occupied by some other crop for a year. The clover sod when turned in the spring does not permit the regular development of the beet root. Even with the best of preparation there will be many small sods left over the field, and when the small tap root of the beet strikes one of these it either branches or stops growing prematurely. In both cases the beet is poor in quality and smaller than it otherwise should have been.

The first plowing and subsoiling, when not done in the fall, should be done early in April, as this enables one to get the first

planting done by the middle of that month. The depth at which to run the breaking plow depends upon the depth of previous plowings. The plow should run about an inch deeper than the ground has usually been plowed. It is a fortunate thing if it is 10 inches deep because subsoiling is then unnecessary. When the ground is subsoiled the combined depth of plowing and subsoiling should be 10 to 12 inches. The subsoiler simply follows in the furrow made by the breaking plow and loosens the subsoil, but does not bring any of it to the surface. The effect of the subsoiler is twofold, as it tends to make a reservoir for moisture and at the same time forms a loose medium for the beet root to penetrate. Soil that has been subsoiled the previous year and those with a comparatively open subsoil need no subsoiling.

The next step in the work is the preparation of the ground for the seed, and the main object here is to get the surface as level as possible so that the seed will be drilled at a uniform depth. The precise method of preparation must be decided upon to suit the conditions, by the one who has the work in charge. In case the soil is sandy or will blow, the surface must be left somewhat rough before drilling.

The drilling is done with a horse drill which sows four rows at a time and is easily regulated as to depth of sowing and distance between rows. The depth of sowing may vary from ½ to ¾ inch; and the distance between rows is usually 16 to 20 inches, depending upon the productiveness of the soil. The richer the soil, the closer the rows may be. The amount of seed to sow per acre varies from 16 to 20 pounds according to the distance between rows.

A part of the sowing should be done by the middle of April and successive portions of the land should afterwards be sown at intervals of 6 or 8 days. The amount of ground which it is best to sow at one time depends upon the total amount of land, and the force available for tending it. The seeding should be so divided that all cultivations and the harvesting can be done just when needed.

Both horse and hand work are necessary in the cultivation and although the latter is very expensive it must not be omitted.

The first cultivation is done with the horse cultivator and it should begin just as the young plant appears. The cultivator takes two rows at once, and at this time the spider wheels and duck feet should be used on it. This cultivation destroys most of the weeds. When the second pair of leaves appear the beets are bunched, thinned and thoroughly weeded. Bunching consists in cutting out part of the beets with a hoe, so as to leave bunches at intervals of 6 inches. Then all beet plants are removed except the strongest one in each bunch; and at the same time this thinning is done, all remaining weeds are also removed from the rows. Now the harder and larger part of the hand work is completed. There is one more hoeing to be done and that, just before the last cultivation. As soon as the beet plants straighten up after the thinning, horse cultivation should commence again. At this time the goosenecks are used on the cultivator instead of the spider wheels. Each succeeding cultivation should be deeper than the preceding ones and cultivation should be continued until the leaves meet between the rows. All the cultivations except the last one can be done with one horse as the cultivator takes but two rows at a time. For the last cultivation the duck feet are used and run as deeply as possible. Four rows may be taken at once and two horses used on the cultivator. The last cultivation of any of the beets should be completed, at the latest by August first.

The beet field need not be again disturbed until harvest time. The proper time for harvesting is determined by a chemical test of the condition of the beets. As a general rule the earliest beets ripen from the first to the middle of September. In harvesting, the beets are lifted with a horse beet puller, and are gathered either into rows or piles and the tops cut off with a knife at the base of the lower leaf. For this work some use short bladed corn knives, while others prefer hand sickles, having 4 to 6 inches of the end of the blade cut off.

Usually the beets are shipped or hauled to the factory as fast as they are harvested. If the yield is very high, so that the factory will run during cold weather, about one-third of the crop must be siloed. Siloing consists in piling the beets and covering them with earth so that they will not freeze nor wither.

The silos should be placed at the end of the field next the road and each should contain 5 to 20 tons of beets. The silo should be long and narrow, and the outside layer of beets laid similar to cord wood, with the top ends on the outside. In this way a regular surface is formed which tends to prevent the dirt from sifting through the pile and also facilitates hauling. The beets are at first covered 2 to 3 inches deep with dirt, and as cold weather comes more dirt is added until the covering is about a foot thick.

It is customary with most factories to pay for beets according to their per cent. of sugar and purity. The Illinois Sugar Refining Company, this year paid $4.00 per ton for beets grown under their direction, and the factory employs men whose duty it is to oversee the growing of the beets. Although the last season was very unfavorable, and the industry is an entirely new undertaking for Illinois, the results show a better average yield per acre than in any other state, about 10 tons. At $4.00 per ton this gives $40.00 for an acre of beets. On an average beets can be grown for about $32.00 an acre, including $5.00 rent, thus leaving $8.00 per acre net profit.

I think these figures are far below what Illinois can do. With early sowing, thorough cultivation and a favorable season, Illinois should produce on her rich land 12 to 18 tons of beets per acre. The cost of caring for a heavy yield is only slightly increased in the item of transportation, and thus it is evident that in good seasons the profits from beet growing in Illinois may be enormous, Little has been done in Illinois to throw light on the subject of fertilizers for beets. Barnyard manure has been found to give very satisfactory results, increasing the yield and not reducing the quality. Fertilizers rich in nitrogen must be used with caution for while they give a greatly increased yield they also lower the per cent. of sugar. Within moderate limits, however, the increased yield may more than compensate for decreased sugar per centage.

CORN FOR WINTER FATTENING OF SHEEP.

By J. K. Hoagland, B. S., Class of 1899.

The predominance of corn, as a farm product in the middle western states, and its extensive use as a fattening feed for nearly all classes of domestic animals, led to the following investigation. An experiment was conducted in sheep feeding to determine the relative value of corn as a fattening feed for sheep, when fed, 1. alone, 2. in combination with oats and 3. with roots (sugar beets).

The flock of sheep selected for the experiment consisted of fifteen grade Shropshire wether lambs, averaging in weight about eighty pounds and being of average quality, not fat but in ordinary condition. Preparatory to starting the experiment the sheep were all fed rations of corn, oats and sugar beets. The experiment was started January tenth and continued to April twenty-fourth, a period of fifteen weeks. The sheep were divided into three lots of five each, as nearly equal in size and quality as was practicable. Each sheep was numbered and the individual weights were recorded. Each lot was then placed in a closed covered pen, about ten feet square, furnished with a trough and rack for feeding. During the last five weeks of the experiment each lot was allowed access to a small lot provided for exercise and sunshine during the warmer spring weather.

The food ration for each lot was made up as follows:

Lot 1. Shelled corn.

Lot 2. Shelled corn and oats mixed; two parts of corn to one of oats by weight.

Lot 3. Shelled corn and sugar beets.

In addition to the above rations all received clover to the amount of about one pound for each sheep per day.

The intention being to fatten the sheep, they were fed all the grain and roots they would consume, the maximum being approached gradually during the first week. The sheep were

fed twice a day, the grain being fed first, and the uneaten portion was weighed back. The clover and beets were fed in the morning after the grain, and grain alone was fed in the evening. The sugar beets were prepared for feeding by passing them through a machine which cut them into convenient pieces.

The sheep were weighed twice at intervals of six weeks, besides the final weight at the end of the last interval of three weeks. The weights were determined by averaging the weighings of Saturday and Monday afternoons. Table 1 shows the individual weights of the sheep at the successive intervals, also the gain and totals for the entire period.

TABLE NO. 1

Showing the individual weights of the sheep at the successive intervals, also the gain and totals for the entire period:

	Sheep No.	Beginning. Pounds.	6 weeks Pounds.	12 weeks Pounds.	15 weeks Pounds.	Gain Pounds.
Lot 1	1	91.	103.	117.	122.	31
Corn	2	88.5	94.5	119.	133.5	45
alone	3	89.	109.	118.	125.	36
	4	66.5	65.5	74.	87.5	21
	5	77.	88.	106.	119.	42
	Total	412	460	534	587	175
Lot 2	1	92.5	99.5	112.	124.	31.5
Corn	2	76.	67.5	75.	81.	5.
and	3	84.	100.5	109.	117.5	33.
Oats	4	81.	94.5	108.	114.5	33.5
	5	73.5	70.	83.	86.5	13.
	Total	407.5	432	487.	523.5	116
Lot 3	1	95.5	104.3	126.	133.	37.5
Corn	2	76.5	76.	86.	103.	26.5
and	3	88.	96.5	112.	121.	33.
Roots	4	69.5	77.5	84.	103.	33.5
	5	85.	87.	88.	90.	5.
	Total	414.5	441.3	496	550	135.5

From this table we see that the best results in gain, both as a lot and individually, came from lot No. 1 which was fed corn alone. This corn fed lot gained 175 pounds, against 116 pounds gain for the mixture of corn and oats, and 135.5 pounds gain for corn and roots. However, if we consider the sheep individually the difference is lessened, for in lots 2 and 3 we find *individuals* which made scarcely any gain and thus cut down the average of

the lot. In lot 1 the average gain was thirty-five pounds, while in lot 2 it was only twenty-three pounds, yet if we disregard in lot 2, numbers two and five which did not do well, we have a gain of thirty-two pounds which lessens the difference. Likewise in lot 3, disregarding number five we would have an average of thirty-two and one-half pounds. The table shows that at no time did the poorer feeders make a good gain, but since we do not know how much these poorer feeders ate we cannot reckon them out of the experiment.

Having considered the effects of the different rations on the sheep, individaully and in lots, we next compare these results with the amount of food consumed and approximate cost of gain, the calculation being in totals for each lot for the entire period.

TABLE NO. 2.

Table of totals, showing the amounts of food consumed by the different lots, together with the cost for given gains:

Food Consumed.	Lot 1 Pounds	Lot 2 Pounds	Lot 3 Pounds
Corn	897	546.6	795
Oats	...	273	....
Beets	...	....	1035
Clover	473	470	465
Total dry matter*	1219	1156	1253
Gain from food consumed	175	116	135.5
Food for 100 pounds gain—			
Corn	513	471	587
Oats	...	235	....
Beets	...	....	764
Clover	270	405	343
Gain for 100 pounds corn	19.5	21.2	17.0
Cost of 100 pounds gain†	$3.56	$5.58	$4.94

Table No. 2 shows that the best results considering the gain and the amount of food consumed, together with the cost of the gain, were obtained by lot 1, which was fed on the single ration of corn, although, as was pointed out in table No. 1, this favorable difference is partly due to the individual peculiarities of some of the sheep. The total amounts of *dry matter* consumed by the different lots did not vary to any considerable extent.

*Calculated from Henry's "Feeds and Feeding" table of composition of American feeding stuffs, page 619.

†Calculated from current prices, viz., corn per bushel 30c, oats 25c, beets $2.00 per ton, clover $6.00 per ton.

We find the smallest gain in the lot eating least, lot 2, although the deficiency is not in proportion to the difference in the amount of food eaten. In considering the food for one hundred pounds gain, we find the best gain for the corn was obtained when it was mixed with oats, but the difference is far from being in proportion to the amount of additional oats necessary to produce the gain. It required two hundred and thirty-five pounds of oats to produce the difference made by forty-three pounds of corn. This shows the oats gave very poor results. The cost for one hundred pounds of gain shows that at present prices the single ration of corn is cheapest and in this case gave best results. The cost of one hundred pounds gain does not show a profit in all cases for the feeding, yet we should consider the carcass of the sheep to have increased in value due to the fattening process, at least one cent per pound, and as a subsequent table will show, part of the conditions under which the sheep were fattened were unfavorable for the best results.

Having considered the experiment as a whole and noted the variations in results for the entire time, we will next divide the experiment into the periods when the fattening process was conducted under different conditions, viz: The first six weeks during the cold winter weather when the sheep were not allowed access to the adjoining lot, and the last period of three weeks when the sheep were allowed free exercise in the openlot. The middle period of six weeks being partly with and partly without exercise.

By reference to table No. 3 we see that the total amount of dry matter consumed by the different lots for any one period did not vary to any considerable extent; however, the total dry matter consumed during the different periods did vary considerably, being larger in amount for each successive period, and being relatively the greatest, as is shown by the weekly consumption, for the last period when the sheep had access to the exercise lot. Likewise we have an increase in gain per week for the last period over the first period as is shown in column "average gain per week." Since the middle period was partly with and partly without exercise we can only attribute the gain as being due to exercise, by the fact that during the last two weeks of the mid-

dle period the lots demanded a sudden increase of feed. The sheep during the last period not only ate more but gained more for amount consumed, the gain for a given period being more than double the gain for a given period without the exercise, while the food consumption was increased but twenty per cent. We would expect the sheep to gain faster during warm weather but would not expect them to consume more food hence we conclude that the better results were probably due to the exercise.

TABLE NO. 3.

Showing the weights of the three lots for the different periods, also showing the amount of food consumed at the diif- ferent periods together with the comparative gain and cost of gain for the different periods:

Weights in Pounds.

	First Period (6 weeks)		Second Period (6 weeks)			Third Period (3 weeks)		
	Jan. 10	Feb. 20	Gain	Apr. 3	Gain	Apr. 24	Gain	Total Gain
Lot 1	412	460	48	534	74	587	53	175
Lot 2	407	432	25	487	55	523	36	116
Lot 3	414	441	27	496	55	550	54	136
Total gain			100		184		143	427
Average gain per week			16.7		30.7		47.7	

Feed Consumed. Pounds.

	First Period.				Second Period.				Third Period.			
	Corn	Clover		Dry Matter	Corn	Clover		Dry Matter	Corn	Clover		Dry Matter
Lot 1	306	191		435	360	210		500	230.5	105		284
Lot 2	197	188	(Oats) 98.5	423	236	210	(Oats) 118	492	114	105	(Oats) 57	241
Lot 3	276	186	(Beets) 417	460	307	207	(Beets) 405	504	193	105	(Beets) 210	289
Dry mat'r consm'd pr wk				219.7				249.3				271.3

The cost of 100 pounds gain was:

During the first period, without exercise $7.06
During the third period, with exercise 3.13

SUMMARY.

This experiment indicates:

1. That sheep may be profitably fattened in winter.

2. That a single ration of corn with clover is the cheapest and best feed at ordinary prices, compared with rations made up of oats or roots in combination with corn, although either may be substituted for the other if necessary.

3. That individual peculiarities have much to do with the fattening and cannot always be detected beforehand; hence we should note the importance of picking out the good feeders as soon as possible, since the few poor ones will cut down the profit of the lot.

4. That moderate exercise induces greater consumption of food, insures better assimilation and lessens the variation of results for the different rations and individuals.

ILLINOIS FERTILITY. Illinois farmers have been accustomed to regard stock-feeding simply as a means of enhancing the value of their farm products. Necessity has not as yet brought us, as it has eastern farmers, to fully realize the importance of soil fertility. But already, the reduced yields of our crops show that this is a matter to which we should attend. The saving of fertility is really of quite as great, and often of even greater advantage to the farmer, than the immediate financial profits of his feeding. Only a small proportion of the fertility of the live-stock farm is sold from it. Growing animals and those giving milk allow 50% to 75% of the fertility of the food to pass into the manure; while from mature animals which are working or fattening and thus building up very little of bone or muscular tissue, 90% to 95% or even more of the fertility passes into the manure. Extensive feeding experiments have shown that food is used principally to supply energy for the life processes. This together with fat formation is accomplished wholly at the expense of the carbon, hydrogen and oxygen of the food—substances which are valueless as fertilizers since plants get them from the air and water. The only drains made on the fertilizing elements are for a part of the constituents of milk and of the growth of bone, muscle, wool, etc. What is the animal then? Simply a convenient apparatus for converting those parts of our crops, which the plants obtained from air and water, into salable meat, wool and milk products of high value, while the fertility of the food is left in the manure for the farmer to use in raising other crops to be used similarly. Have we not, therefore, lost the link connecting the two ends of our economic chain when we fail to utilize the manure of our farm animals? E. T. R.

THE AMERICAN HORSE MARKET AS RELATED TO THE FARMER.

By J. P. Finch, Class of 1903.

The American horse market has at last become one of the fixed markets for the produce of the American farmer, and it is with a great deal of satisfaction that the farmer may view the situation as it is today. Good horses of all the different classes are bringing a fair price. Since 1893 there has sprung up an export demand for our horses, and American bred animals now go to Great Britian, France, and Germany, each country requiring a horse of a particular type. The call for good horses is steadily increasing, and the American farmer with all his advantages is expected to produce them. We have proven that we can put on the market as good if not better horses and at less cost than they can be produced in the Old World.

There are six classes of horses which find ready sale on the American market today:

Class No. 1. Drivers and Coachers. These must be of good form and color, well bred, from 15¾ to 16½ hands high with fine heads and necks, and plenty of bone and substance. The one thing which must not be lacking is good action. No matter how well proportioned the horse may be he cannot enter this class if he cannot "go high" and keep it up. They range in price from $100 to $300 Some very rare specimens have reached the $1,000 mark.

Class No 2. Cab Horses. These must be fair travelers, weighing about 1100 pounds, standing from 15¼ to 15½ hands high, with good bone, and rather blocky. They are not profitable horses to raise, but at the same time the breeder will always get some of these in breeding for classes 1 and 3, although he may do his best to avoid it. For this reason the market is always well stocked with this class although the price is low—$75 to $100.

CLASS NO. 3. BUS HORSES. These horses are blocky, smoothly made animals, must shape themselves well in the harness, and have good bone and action and weigh from 1200 to 1400 pounds. The more blocky of these are taken by the English buyers at $90 to $130 for bussers, while the heavier ones are used for expressers in America.

CLASS NO. 4. DRAFT HORSES. These should weigh from 1700 to 2200 pounds, the larger the better as long as they are well shaped. This horse should have both ends right as well as the middle; the bone large, clean, flat and strong; feet open, with no appearance of side or ring bones, and with legs well set under the body. In general, he should be of a neat, compact and finished appearance, with a good masculine gait, especially while walking, as this is the gait in which he does most of his work. The price of this class is $100 to $300.

CLASS NO. 5. AMERICAN TROTTERS. In all cases, the horse of this class must be well bred and a good goer. The price ranges from $60 to $5,000, according to speed.

CLASS NO. 6. AMERICAN GAITED SADDLE OR HIGH SCHOOL HORSES. These horses should have at least five gaits, and they may have seven, viz., walk, trot, canter, running walk, fox-trot, single foot, and slow pace. They must be well made, pretty horses and when such command good prices.

For the American farmer who is burdened with so many cares which divert his attention, there is but one of these classes that he can afford to raise and prepare for the market. The drivers, coachers and saddlers must be raised and trained for the market by one who has the time to devote to it. And he must also make a thorough study of the horse and have a liking for him that almost amounts to an affection. The cab horse is too small to be of any use to the farmer, and while he will by chance produce one of these occasionally, to make a business of breeding them would be to incur a loss. The bus horse will sell well if he is just what the buyer wants, but there are many chances for him to fall into the cheap class and if he does, he will have to be sold for less than the cost of production. As to the American trotting horses, the farmer had better stay in the other field, or he may sit on the fence and watch them go by, for there is only

which wins and those which fall behind are of no real value to the farmer.

The American draft horses present many possibilities to the farmer for gain in proportion as he improves his opportunities. Just as easily as the steer can be raised, requiring nothing more of the herdsmen than something good to eat and a place to sleep, so may the draft colt be raised. He needs no especial handling until he is three years old, when he can be broken by simply hitching him by the side of a quiet team, and starting him out across the fields with a plow, in the hands of a judicious man. When night comes he cares nothing for the loose straps which hang about him; all he wants is good feed and a place to rest. He will also appreciate a slap on the neck with a "Well done, good old fellow, I will let you rest tomorrow." With judicious handling he will do two season's work, before he is of marketable age. If you will then repay him for his labor by giving him a four months course of heavy feeding, so as to get him very fat he will bring $200. There is little danger in getting him too fat but there is usually error the other way. The market demands that draft horses be very fat and the prices range accordingly.

In conclusion my fellow farmers we have the most important part of our subject to consider. Draft horses are not produced from Shetland ponies or mongrel-bred horses. After you have secured the best dam possible you must be very careful in selecting a sire. He must be of good breeding, with size, quality and action, and must be sound. A few dollars expended on a service fee is your most economical investment. To patronize cheap and inferior stallions is only to help flood the market with trash, and at the same time to disgust yourself with the horse business and lose time and money.

THE SCIENCE OF BREEDING.

By W. J. Kennedy, B. Agr., Instructor in Animal Husbandry.

The science of breeding is difficult and abstruse, and is founded on various laws, some of which are still imperfectly understood. The disappointments and failures which occur in stock-breeding are mainly due to an imperfect knowledge or a disregard of these laws. A consideration of some of the principles and conditions which should guide the breeder's art may accordingly form a profitable subject for examination.

The primary and generally recognized axiom, that like produces like, need not be enlarged upon nor illustrated. The distinctive racial types are notably hereditary. Darwin taught "that all characters of all kinds, whether new or old, tend to be inherited, and those which have already withstood all counteracting influences and have been truly transmitted will, as a general rule, continue to withstand them, and consequently be faithfully inherited." But like does not always produce like. Male and female of the same breed, or even of the same family, when mated, produce progeny exhibiting notable individual differences. This tendency to variation is sometimes exaggerated, and "sports," as the horticulturist terms them, result. These variations have afforded materials from which have been formed the numerous so-called breeds of our domestic animals. Variation is sometimes traceable to the law of reversion, i. e., of the appearance of ancestral characters. Examples of reversion are constantly met with, and are especially frequent where short-pedigreed, cross-bred, or otherwise faulty sires have been used. Among the heavier breeds of horses, the light carcass and thriftless habit, rough, coarse, round limbs, short pasterns predisposing to ringbone, as well as peculiarities of gait or temper, which have marred the remote ancestors of the sire are liable to appear in his descendants of the third and fourth generation. Amongst some of our longest cultivated white breeds of

hornless sheep occasional individuals appear with black spots and rudimentary horns, testifying to the persistent descent of ancient character which crop out after having remained latent for several generations. Darwin, in his work on "Animals and Plants under Domestication," records a remarkable instance of this persistence of ancestral character in pigeons. The numerous varieties, differing so greatly in color, feather, and even in structure, are descended from the Blue Rock, which has a slaty blue color with dark bars on the wing feathers. In many modern sorts the blue color and feather markings have disappeared; but, although absent for generations, when two of these varieties are crossed, the ancient insignia reappear in many of the progeny. In moulding animals for special uses, and maintaining acquired types, breeders have constantly to battle with this tendency to reversion. In a few generations the numerous artificial varieties of pigeons, if allowed naturally to intermix, would revert to the original Blue Rock. Modern dairy cows, amidst unfavorable surroundings, in much less time than it has taken to bring them to their profitable yield of milk, would furnish only sufficient for their own calves.

Prepotency is a principle not well understood. It occurs in certain races, species, and individuals. The jackal in prepotent over the dog, the ass over the horse, the pheasant over the chicken. The Blue Rock male, as already indicated, imparts its slaty blue color to its progeny when crossed with almost any other distinctive breed of pigeons, of whatever color. Among cattle, the prepotency of the Texas and the Shorthorn is very marked, as may be shown by the rapidity with which a few crosses of either of these sorts absorb or obliterate the characters of other bovine breeds. The darker colored sheep seem to have a stronger transmitting power than the lighter ones. Prepotency cannot always be measured by the antiquity of a breed. Darwin pointed out that trumpeter and fantail pigeons, although distinctively bred for upwards of a hundred years, and breeding perfectly true within their own kind, when crossed with other varieties of pigeons, some of more recent origin, quickly lost their distinctive characters. Prepotency is sometimes notable in one, sometimes in the other sex. The male donkey

appears more prepotent than the female, as exhibited in the distinctive characters of the mule and the hinny. The Arabs look to the pedigree of the mare rather than the horse, which attests their belief in the prepotency of the mare. Crossing tailless Manx and other cats appears to demonstrate that the male cat is more prepotent than the female. Darwin offers the following explanation of prepotency: "It apparently depends upon the same character being present and visible in one of the two breeds which are crossed, and latent or invisible in the other breed; and in this case it is natural that the character which is potentially present in both should be prepotent. Thus we have a reason to believe that there is a latent tendency in all horses to be dun colored and striped; and when a horse of this kind is crossed with one of any other color, it is said that the offspring are almost sure to be striped. Sheep have a similar latent tendency to become dark-colored, and we have seen with what prepotent force a ram with a few black spots when crossed with white sheep of the various breeds colored its offspring. A nearly parallel case is offered by those black bantams, which, as they grow old, develop a latent tendency to acquire red feathers."

The male and female parents are believed to contribute in about equal proportion to the conformation and characters of their progeny. But certain conditions modify this equal proportion. The best bred and most vigorous parent is apt to exert a dominant power. Hence, intelligent stockraisers are most careful in their selection of consistently bred sires, whose ancestors for several generations have exhibited the desired characters and qualities. Of special value are animals, male or female, which conjoin this prepotency with the good points sought to be produced. The likeness of the progeny to each of the parents is subject to other modifying conditions. Some recognized authorities claim that the bony frame, the gait, and the skin and its appendages, notably follow the male parent; while the internal organs, the endurance, and temper, more generally follow the female parent. It is possible that prepotency might have this influence. This is apparently illustrated in many cases where animals of different breeds or varieties are crossed. The

progeny of the donkey mated with the mare exhibits the head, ears, tail, hair, and gait of the ass in more marked prominence than when the stallion is put to the female donkey. Breeders of poultry recognize that the size, skeletal formation, and plumage notably follow the male bird, while the production of eggs and the sitting habit more particularly follow the female.

Other conditions also tend to give prominence in the offspring to the characters of one or other parent. It has been observed that in many instances the female progeny more closely resemble their male parent, while the male progeny more resemble the female parent. In this connection, it may be noted that many superior stud horses and pedigree bulls have sired numerous "crack" females, but comparatively few have been remarkable as sires of superior males. It is the highest achievement of stock-breeding to produce first-class prepotent males. To do so appears to demand a high standard of merit in both parents, and required that for several generations both shall have been bred to the desiderated type, with the use of judgement and experience in mating. When parents differing in character or type are crossed, the progeny do not represent a harmonious mean, but usually have some of the character of each parent. Thus the union of horses very different in size, style, or substance, usually produces uncertain and unsatisfactory results. Such incongruous unions are frequently disfigured by a coarse head, a body too heavy for the legs, or the want of stamina. Where several young are produced at a birth, the produce of an ill-assorted union is apt to comprise individuals representing each of the dissimilar parents. Darwin, in the work above referred to, states that "when gray and white mice are paired the young are not piebald, or of an intermediate tint, but are either pure white, or of the ordinary gray color. If you cross a black with a white game, you get birds of the clearest color of each breed. Sir R. Heron crossed during many years white, black, brown, and fawn-colored Angora rabbits, and never once got these colors mingled in the same animal, but often all four colors in the same litter. When turnspit dogs and ancon sheep, both of which have dwarfed limbs, are crossed respectively with common breeds, the offspring are not inter-

mediate in structure, but resemble either parent. When tailless or hornless animals are crossed with perfect animals, it frequently but by no means invariably, happens that the offspring are either perfectly furnished with these organs, or are quite destitute of them."

No adequate explanation of this has been offered. Still more inexplicable is the phenomenon noted by various observant breeders, that the pairing of two animals each of which possesses a peculiar character in a remarkable degree, is not always the most effectual method of reproducing this character. Darwin states that he "has been assured by breeders of canaries that, to get a good jonquil-colored bird, it does not answer to pair two jonquils, as the color then comes out too strong, or even brown." So, again, if two crested canaries are paired, the young birds rarely inherit this character, for in crested birds a narrow space of bare skin is left on the back of the head where the feathers are upturned to form the crest, and, when both parents are thus characterized, the bareness becomes excessive, and the crest itself fails to be developed. Mr. Hewitt, speaking of laced Sebright bantams, says that "why this should be so I do not know, but I am confident that those that are best laced frequently produce offspring very far from perfect in their markings; whilst those exhibited by myself, which have so often proved successful, were bred from the union of heavily laced birds with those that were scarcely sufficiently laced."

The progeny, so some of our recognized authorities claim, sometimes exhibit the characters, not of their actual sire, but of the male parent with which the dam has been previously mated. This apparently does not depend, as has been suggested, on an impression produced on the female imagination, but apparently upon the ova, which, although not fertilized, are perhaps sometimes affected by the first male. Mares that have been bred to a donkey, and are subsequently mated with a horse, oftentimes produce foals betraying the former alliance. Thoroughbred mares which have been bred to a coach horse, throw foals of unusual size and substance, but partaking of the qualities of the former sire, and hence are seldom of any value on the turf. An Aberdeen Angus or West Highland bull used on Shorthorn cows

leaves its mark on the calves which these cows may subsequently produce from Shorthorn bulls. A purebred pointer, retriever or other distinctively bred dog lined by a mongrel, or by a dog of a different breed, and in subsequent seasons mated with a dog of her own kind, produces a succession of litters in which several of the whelps have the mongrel or incongruous markings.

The state of health of the parents at the time they are mated has a controlling influence upon the offspring, and the material impressions experienced then and throughout the period of gestation, are supposed by some to exert notable effects on the progeny. The Arabs give both horse and mare a smart gallop before they are mated, believing that the intensified energy thus evolved is in part transmissible. A somewhat similar view appears current in Great Britain amongst stallion owners, many of whom assert that stallions are more certain, and get their best foals when used late in the day, after they have had a considerable amount of exercise. Flockmasters often take pains to have their ewes steadily improving in condition, especially when desiring an extra proportion of rams.

It is exceedingly questionable, however, whether whitewashed byres produce, as has been claimed, a preponderance of light-colored calves, or that Mr. McCombie of Tillyfour, intensified the black of his favorite "doddies" by blackening the fence of his mating paddock; or that the leading of a parti-colored gelding before mares when brought to the horse will secure, as has been stated, piebald foals. Is it not feasible for us to believe that many of these peculiarities in the offspring ascribed to imagination of the female parent result from other causes, probably from reversion? It is admittedly a difficult subject. There is, however, good evidence to prove that maternal impressions at the time of impregnation and during the gestation period do exert notable effects on the progeny in the way of foetal nutrition, giving rise to arrested or abnormal growth, and sometimes determining abortion or premature birth. Violent and disagreeable mental impressions are sometimes as injurious to pregnant animals as physical hurt, depending, e. g., on a bad fall, or struggling in an awkward position. Temper and fright are notably prejudicial. A fire at a breeding establishment

has led to abortion, malpresentations, and deformed offspring. Ewes, when torrorized by strange dogs, have suffered in a similar manner.

Color in domestic animals, as in flowers, is one of the most variable characters. Nevertheless, with careful breeding during several generations, and avoiding the disturbing conditions referred to, a tolerable uniformity can be secured. Darwin, in his "Animals and Plants under Domestication," records that Hofacker gives the result of mating 216 mares of four different colors with like colored stallions, and without regard to the color of their ancestors. Of 216 foals born, only eleven failed to inherit the color of their parents. Other German authorities, from observation in the imperial and other large studs, assert that, "after two generations colts of a uniform color are produced with a certainty." Our own experience would lead us to doubt that a stud gathered at random would breed true to color in two generations.

In recapitulation it may be stated that, in breeding animals of whatever sort, the best obtainable should alone be used. The influence of inheritance is too strong, and life is too short, to justify the attempt to grade up and improve inferior specimens. Inheritance is the most universal and unfailing law of descent. The conformation and quality of the parents, whether physical, mental, or moral, whether good or bad, reappear in the progeny, which, moreover often revert, reproducing characters of remote ancestors. This reversion, and the influence of external evironments, usually explains the variations which appear even in carefully bred animals. Special pains are generally taken in the selection of the usually polygamous mate. He should always be purebred. The crossbred sire cannot be depended upon for reproducing even the good qualities which he may exhibit. The latent characters of his mixed descent often reappear with disappointing results. Where fixity of type is desired, prepotent strains should be sought for, and a good prepotent animal, whether male or female, should be used as much as possible. In order to rear high class animals of uniform type, and with the capability of transmitting this type with certainty, both parents must be purely bred, and must be fairly alike in conformation and other characters.

ORCHARD CULTIVATION.

By W. S. C. Cottingham, Class of 1902.

It has been found by experimentation that if an apple orchard makes a normal growth of wood and at the same time produces a good crop of fruit, it will have to transpire through its leaves an amount of moisture equal to a rainfall of at least sixteen inches. There are very few Illinois soils, which at the beginning of the growing season, will contain in the upper six feet an amount of water equal to eighteen inches of rainfall; and during May, June and July the rainfall rarely exceeds eleven inches for this region. But of this possible twenty-eight or twenty-nine inches of rainfall which we may have at our disposal, we must remember there are eight or nine inches of which the tree can make no use, owing to the fact that the roots are unable to obtain moisture from a soil after its water falls below a certain per cent. By a little study of the above figures, we find that in favorable years, if our trees are to do their best, we have only two or three inches of rainfall to spare. How to husband this water supply and allow as little as possible to escape, except through the leaves of the tree, is our problem.

The subject naturally comes under two heads, first, that of fitting the soil to hold the largest amount of water, and second, preventing the escape of the water after we have it in the soil.

The greater part of the first will have to be done before setting our orchard. The field must be well drained, and even if good natural drainage exists, tile drainage will be of an advantage, in that it loosens up the soil, thereby increasing its permiability and water holding capacity; and it also lowers the water table to such a depth that it is not detrimental to the tree. Another effect of tile drainage, which is often overlooked but is of great importance, is the fact that better aëration is secured. If we have a hard pan near the surface it should by all means, be

broken by subsoiling. When we consider the vast amount of work the root system has to do to penetrate a hard subsoil, we easily decide to help the tree by breaking the subsoil for it. We are rewarded by finding the root system not all near the surface, but striking downward. The ability of the soil to receive and hold the rainfall is also greatly increased by subsoiling. Preference should always be given to a soil that has been for a time in good cultivation, rather than to use new ground; but we must be sure that the soil is not worn out, and contains a good supply of humus and mineral fertility. The humus supply, however, can be easily increased by plowing under some green crop.

After we have our land in good mechanical condition and our trees set, we are ready to consider and decide the difficult question of how now to treat the orchard. Shall we seed it down, raise some hoed crops, or practice clean cultivation? The last mentioned treatment will consume more of our moisture than either of the other two, but is it a good practice? The opinions of a few men, who have made orcharding a part of their life work, are as follows:

"I have observed a superiority, both in quality and size of fruit, in orchards under the plow over those in clover or grain."

Wm. Coxe, A View of the Cultivation of Fruit Trees, 1817.

"Fallow crops are best for orchards—potatoes, roots, corn, and the like."

A. J. Downing, The Fruit and Fruit Trees of America, 1845.

"All sown crops are to be avoided, and grass is still worse. Meadows are ruinous."

John J. Thomas, The Fruit Culturist, 1847.

"The most profitable crop to raise between the trees is cultivators."

Prof. L. H. Bailey, Bulletin 72, Cornell Experiment Station, N. Y.

"One word gives the key to the idea, and that word is *cultivation*."

Prof. T. J. Burrill, Transactions of Illinois Horticultural Society, 1897.

"If you are going to grow apples, go into it for apples, and do not try to get two or three crops from the same land."

Prof. J. C. Blair, Transactions of Illinois Horticultural Society, 1898.

In bulletin 52 of the Illinois Experiment Station are given the results of an experiment to determine the influence of various treatments upon the growth of apple trees. From this bulletin I take the following average results:

Ben Davis.

Plat.	Circumferance of tree at base. Inches.	Height Feet.	Height Inches.	Diameter of tops. Feet	Diameter of tops. Inches.	Treatment
1	19 3/16	18	9¾	15	4	Clean cultivation
2	16 11/16	18		13	6	Cropped with oats
3	20¾	18	3¾	14	4½	Cropped with corn
4	18¾	17	6¾	13	10½	Cropped with clover
5	9⅜	11		8	3	Seeded to blue grass

Grimes Golden.

Plat.	Circumferance of tree at base. Inches.	Height Feet.	Height Inches.	Diameter of tops. Feet.	Diameter of tops. Inches.	Treatment
1	12¼	14	1¾	10	¾	Clean cullivation
2	9	11	10½	7	7	Cropped with oats
3	14½	14	9	10	7½	Cropped with corn
4	10¼	12	11	8	11¼	Cropped with clover
5	8⅛	11	3	7	6	Seeded to blue grass

From these opinions given and this actual field proof, I think we can answer the first of our three questions by saying, never use an orchard for a sown crop, hay or pasture.

Whether we shall raise some cultivated crop between our trees or not is more of a local than a general problem, and will have to be settled by each individual for himself, by trying the effects of both plans. There are, for instance, a certain class of clay soils, some of which are to be found in Southern Illinois, which it would be ruinous to expose to the full effects of the hot summer sun ; in fact they should be kept protected the whole year from beating rains and sun. With such lands of course we can not practice clean cultivation. From our table above, it would appear that cropping with corn is a benefit. In this case the trees were so close together (15 feet) that after the second season the corn made a very small growth. Experiments at other stations have shown the deleterious effect of cropping with hoed crops, where the trees were far enough apart to allow the cropping to be carried on for a number of years. But I think we might safely say for this section of the United States, that during the first three or four years after an orchard is planted, some hoed crop, such as early potatoes, corn, etc., planted between the trees, and well cultivated, would do no great damage, and might afford protection from sun, wind, and certain insects. It would also help repay the expense of cultivating the orchard.

After an orchard has reached its bearing age it seems doubt-

ful if the practice would be a good one. The orchard is going to make a drain upon the fertility of the land for at least twenty years. Will this land each year have enough moisture, and furnish enough plant food, to make a normal wood growth, and produce a maximum amount of fruit, and still have a surplus for a secondary crop? If so, certainly grow some crop between the trees. But generally it will be found that each will rob the other. Which is the more profitable, the secondary crop, or the fruit lost as a result of its robbing the trees of needed plant food?

If the former, why grow the fruit at all? Our clean tillage, if we adopt this method is not a great problem, and the work can be done with tools found on any farm. It merely consists in keeping a dust mulch upon the ground continuously up to midsummer. The first operation in spring is plowing. This should be done as early as possible, to stop excessive evaporation and aid in warming up the soil. If the land has been fitted properly before setting the trees, no trouble will be occasioned by the roots, and we can plow rather deeply—a thing which we need to do. Even in an old orchard, having its roots very near the surface, we can do this early stirring of the ground, if not with the plow then with the disc or spading harrow. After plowing, the ground should be worked until it is in a uniform, mellow condition. All the later cultivation can be done with a common smoothing harrow, supplemented by the disc when required. There are various tools recommended for orchard cultivation, most of which are good; in fact any tool that will produce a level dust mulch of two to three inches depth, and which allows working close to the trees, is suitable for this purpose. We must be careful about wounding the trees. Harness having low hames and no metal turrets, and protected single trees, will lessen this evil.

After cultivation has ceased it seems advisable, for many reasons, to cover the ground with a catch crop instead of allowing it to pass through the winter bare. The plants used as a catch crop will take up the soluble plant food that otherwise would be leached out before spring and be lost; and they store it in their tissues to be returned to the soil upon their decay, at a time when the trees are especially in need of plant food. During

winter the catch crop will prevent washing of the soil and allow the snow and water to percolate more readily into it. The catch crop also has a tendency to mitigate the evil effects of sudden changes in temperature. Plowed under in the spring, it furnishes humus, thereby improving the texture and water-holding capacity. If the soil is deficient in nitrogen, we have a very cheap means of furnishing it by choosing a leguminous plant for the catch crop. We must remember that this cover crop, if alive the following spring, must be plowed under very early. Otherwise it may become a detriment by sapping the ground of moisture, and when plowed under late will be of such rank growth as to prevent decay, thereby losing a part of the benefit.

Besides the conservation of the moisture content of the soil by clean cultivation, there are several other benefits which are of great importance. These class themselves under two heads: The mechanical condition, and the augmentation of chemical and biological activities. Under the first, by pulverizing the soil we present greater feeding surface for the roots; by increasing the tilled depth we increase the foraging area, decrease capillarity when it is too great, and promote aëration; and by tile drainage we warm the soil and lower the water table to that depth which promotes the best growth, as well as reduces the extremes of temperature and moisture. Under the second, we promote nitrification; aid in setting plant food free; hasten decomposition of organic matter, and extend all three of these agencies to a greater depth in the soil.

In conclusion, we must not forget that cultivation can be overdone. Too frequent or too late cultivation prolongs wood growth so late that there is danger of it not ripening in time for winter. Good cultivation is only one of the four grand principles which the orchardist will have to practice if he expects the best results; so while we are thinking of cultivation let us not forget the other three—intelligent spraying, systematic pruning and supplying the trees with plenty of plant food of the proper kind.

IMPROVEMENT OF INDIAN CORN.

By A. D. Shamel, B. S., Assistant in Farm Crops.

The most practical way for the farmer to improve his corn is by the plat method. This plan is inexpensive and can be carried out by any farmer, and it contains all of the essential principles used by the best seed growers and experimenters in the United States for the improvement of agricultural plants. For the plat, select a square piece of ground (five acres is large enough for 160 acres of corn), preferably on the west side of a field to be planted to the same variety of corn. The soil of this plat should not be of more than average fertility, for it is found that the best quality of any kind of seed is not obtained from very rich ground. The plat should be plowed with the rest of the field and fitted for planting in the ordinary manner. In selecting the seed there are several important points to notice. In the first place, the variety used should be adapted to the length of season. In the northern part of the state earlier varieties should be used than in the central or southern sections. For instance, the Boone Co. White variety will not mature in the northern tier of counties, while it matures in ordinary seasons in most of the central and all of the southern counties. Any variety can be adapted to the locality by selection through a number of years, but it is a safer practice to plant that variety, already best suited to the climate.

Before planting time the vitality of the seed should be tested. This can be done by selecting at random several ears of the seed corn and shelling off a couple of rows from each ear. A few kernels from each ear are then placed in the germinator. It is convenient to have the numbers factors of 100, *e. g.*, 10 ears and 10 kernels from each ear; then from the 100 kernels the number which germinate is the per cent. of germination. A simple and effective germinator is made by filling a shallow box with moist earth and covering the earth with a layer of soft

heavy cloth. Lay the kernels on this cloth, cover the box with a board and set in a warm place. In a few days the seeds will begin to germinate, and within ten days all will have germinated that would grow under field conditions. Ninety per cent. should germinate ; and if this test shows a lower per cent. than this, other trials should be carefully made to verify the result. If the indications are that the seed will not uniformly give a germination of ninety per cent or better, then that lot of seed should be discarded and a fresh supply obtained.

It is a good practice to shell off the tips and butts of the ears separately and not plant them. The reasons for this are—first, if any part of the ear is mixed it is always noticed in the tip or the butt ; and second, these kernels are always irregular in size, and consequently prevent getting an even stand with the planter.

The selection of seed for the special plat should be very carefully done. In picking out ears to plant, one of the best guides that we have in making such selection is the score card adopted by the Illinois Corn Growers' Association. It is as follows :

POINTS USED IN SCORING.

1—Uniformity of exhibit	5
2—Shape of ear	10
3—Purity of color in both grain and cob	10
4—Ripeness, indicating market condition	5
5—Filling out at ends	15
6—Perfection and uniformity of grain	8
7—Length of ear	10
8—Circumference of ear	5
9—Space between rows	10
10—Proportion of grain to cob	22
Total	100

Standard of Perfection A perfect ear of corn should be 10 inches in length, 7½ inches in circumference, and should yield 90% of corn. The ear should be cylindrical in form, and carry its size the entire length, except near the point where it should taper slightly. By "filling out at ends" is meant that the tip should be completely covered with kernels, and the kernels on the butt should extend out around the shank so that all possible space on the cob will be occupied by kernels. This will result in a large per cent. of corn. The kernels of an ear

begin to mature at the butt, those of the middle are next and the tip kernels last; also in the case of the pollen on the tassel, that on the lower branches matures first and the pollen on the top branches last. When an ear is not filled out it means that the tip has matured too late for the pollen to fertilize it. or in the case of the butt the silks have matured too early, the pollen not yet being ripe and ready to fertilize them. If the ends of an ear with widely differing periods of maturity are filled out, it means that the pollen of an early or a late variety has fertilized them, resulting in a mixed ear. In a well filled ear not mixed, the different parts of the ear have been brought to such an even condition of maturity that the pollen of the particular variety has opportunity to fertilize all parts of the ear.

Mixed ears should not be used for seed because the nature of the product is uncertain and usually a coarse type, which will run out under ordinary conditions and require the frequent necessity of obtaining fresh seed. Ears with space between the rows, i. e., those in which the kernels are broad and rounding and do not come close together at the top but leave a space, indicate a shallow kernel and large cob. By most authorities this appearance is considered a sure indication of running out of the variety instead of advance or improvement. This appearance of space between the rows is usually accompanied by a smooth kernel. This indicates a tendency toward the flint varieties grown in the north. A flint kernel begins to harden on the top, the outside of the kernel exposed to the weather, and the chit is the last part to mature. The kernels can only develop so long as the seed coat is soft and capable of extension, and so when that begins to harden the development of the kernel is stopped. In the dent varieties, on the other hand, the kernel begins to harden at the chit, gradually maturing outward until the season cuts short the development. Then the seed coat shrinks back and makes the dent, giving rise to the name of dent varieties. So a kernel having a rough top side, that is a deep dent indicates a deep kernel and consequently a small proportion of cob to corn with a possibility of still further development. By selecting ripe, fully mature ears the length of season for the variety may be adapted to the conditions of the locality in which it is grown.

An even exhibit, i. e., one in which all of the ears have the same general appearance, indicates good breeding and is one of the most important points of excellence. It is a very noticeable fact that wherever this score card has been in use for several years, the quality of corn has been greatly improved.

The seed for the special plat having been very carefully selected, should be planted when the soil is warm and moist, so that the young plants will start to growing vigorously and produce strong, healthy plants. Shallow cultivation will give the best results. When the field is cultivated deeply the roots of the corn plants are injured, and consequently the plants' supply of food is cut off in proportion to the amount of roots injured. If the field is weedy the weeds should be removed by frequent rather than deep cultivation. This method will produce a fine loose mulch which will assist in conserving the soil moisture.

As soon as the ears begin to set so that the character of the stalk can be determined, all of the poor and barren stalks should be cut out of this plat from which the seed is to be selected. This will largely prevent the fertilization of the ears that will be selected for seed, by pollen from poor, broken and dwarfed stalks, or stalks that produce no ears. If the pollen from these poor stalks should fertilize the seed, the seed would have an inherent tendency to produce poor and barren stalks. This fact has been proved at the Illinois Experiment Station beyond a doubt, and it has been found that the process just described will, in the course of a few yeas, remove a large per cent. of the poor and barren stalks which are a prolific source of poor yields in our Illinois corn fields.

The seed for the next year's crop should be selected from the special plat, care being exercised to select ears with the aid of the score card, and from strong, healthy stalks. There is every reason to believe that the stalk influences the ear just as strongly as the cow influences the calf; hence it is necessary to use care and judgment in selecting seed from well-developed stalks. The most perfect ears from this plat should be selected for planting a similar plat the next year. Thus the improvements made each year are perpetuated in the seed corn plat, and turned to account in producing a high class of seed for the whole farm. If the

work is carefully done it will be found in a few years that the corn of this plat has become far more uniform and perfect than it would be possible to get seed corn by selection alone from the ordinary crop.

After the seed is husked it is very important to keep it under the most favorable conditions through the winter. For this purpose it should be kiln-dried. This drying can be done in some convenient room. Keep a fire burning for three or four weeks, so as to gradually dry out the excess of moisture. The drying process should be renewed during long, damp periods of weather. In any event keep the seed from mice and rats. It is not advisable to use old seed. Age causes a loss of vitality, and it is always best, where possible, to use seed from the previous year's crop.

The breeder must have a certain type as his ideal, so as to have constantly in mind the kind of corn he wishes to plant; then by selection he can bring the type close to his standard. The results are not accomplished in a single year even by the most expert breeders, for it takes years to change a type. The encouraging feature is that the whole question of breeding corn is new, and we are just beginning to see the great possibilities of increased yields per acre through better seed and varieties adapted to particular purposes and localities.

DAIRY FEEDS. The dairy cow, to do her best at the pail, must have about 2.5 pounds of digestible protein in her daily food ration. As the other food ingredients are usually present in excess in our feeding stuffs, the protein of the food is the main thing to consider. Basing values on digestible protein, when bran is $15 per ton, other foods are worth for dairy cows as follows: Oats, 18½c per bushel; clover hay, $7.50 per ton; corn stover, $2 per ton; corn fodder, $3 per ton; corn silage, $1.08 per ton; gluten meal, $30.96 per ton; oil meal, $36.60 per ton. At this winter's prices, gluten meal $20, and bran $15 per ton, the former furnished digestible protein at less than 4c per pound, the latter at 6c. This winter for the University dairy herd, gluten meal was used instead of bran to supply the necessary protein. The cows have not only held their own, but have increased their flow of milk from 1 to 3 pounds per cow. W. J. K.

THE

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AGRICULTURIST

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PREFACE.

In presenting this issue of the Illinois Agriculturist, the Agricultural club wishes to extend its greeeting to the many friends of the publication. The members of the club appreciate very highly the educational advantages which the people of the state have put within their reach, and it is their desire to present to their friends, through the agriculturist, accounts of some of the work which is being done by the students themselves. This is the reason for devoting so much space to contributions of this nature.

The biographical sketch of the late Professor G. E. Morrow, contributed by Thomas F. Hunt, Dean of the College of Agriculture and Domestic Science, Ohio State University, is given the prominent place which it occupies, not only because of the local interest which we feel in the subject of the sketch, but because of the very extended influence which he exerted upon agricultural education in general; and also to bring to the attention of young men the record of the life and work of a truly great man, in the hope that it will inspire to greater endeavor in the work to which he devoted his life.

A shadow has been cast over the Agriculturist since going to press, by the sad and unexpected death of Mr. Donald F. Berger, the Business Manager, who had labored so faithfully to make this annual worthy of the Department of the University which it represents. In his death the club sustains an irreparable loss and the cause of agriculture a loyal and efficient worker.

DONALD F. BERGER.

Donald F. Berger, the only son and child of Rev. A. J. Berger, of Anna, Ill., was born Oct. 29, 1877 in Champaign, Ill, his father being at that time pastor of the First Presbyterian church. His early education was received in the public schools, and at the age of 19 he entered Earlham College, Richmond, Ind., where for two years he did most creditable work, entering the College of Agriculture of the University of Illinois in 1898 without examination, at which institution he was an earnest, diligent, zealous and untiring student until, by an attack of la grippe, he was compelled to abandon his work. An illness of two weeks culminated in his death, which occurred on Thursday, Jan. 31, 1901.

His special work in horticulture, which he had chosen as his lifework, was of very high order, and indicated, in a measure at least, the character of endeavor for which he was training himself. He wonld have graduated in 1902, and had selected for his thesis work, an investigation of "The development of flower buds and of fruits."

February 1, 1901.

Rev. A. J. Berger,

Dear Sir: At a meeting of the Faculty of the College of Agriculture the undersigned were appointed a committee to express to you in the name of the Faculty most sincere and heartfelt sympathy in the loss by death of your son Donald. He had endeared himself to us all by his uprightness of character, by his gentleness and gentlemanly demeanor, by his earnestness and success as a student, and by his high ideals of life.

We mourn with you on account of what seems to be his untimely death, but we rejoice in his memory and feel confident that such a life does not end on earth, and that a blessed reunion awaits hereafter the faithful.

(Signed) T. J. Burrill,
J. C. Blair.
Committee.

TABLE OF CONTENTS.

George Espy Morrow

GEORGE ESPY MORROW, LL.B., A.M.

Agricultural Writer and Professor, and College President.
Born, October 19, 1840. Died, March 26, 1900.

I have been requested by the editor of this annual to prepare a brief sketeh of my beloved teacher and friend. While I feel, myself, entirely inadequate to the task, a demand so imperative could not be declined. My task has been lightened by the admirable unpublished biography, written by his brother, Josiah Morrow, Lebanon, Ohio,—author of the biography of Thomas Corwin,—kindly placed at my disposal and freely used.

It was late in the memorable political campaign of 1840, that the subject of this sketch was born on a small farm bordering the Little Miami river in Warren County, Ohio, and within one-half mile of the old mill of Governor Morrow.

George was the youngest of nine children, six sons and three daughters, of John and Nancy Morrow. His parents were among the first white children born in the neighborhood in which they lived and died. The father, John Morrow, was the eldest son of Governor Jeremiah Morrow, who was a man long distinguished in public service. The Morrow family is of Scotch-Irish extraction and all of Professor Morrow's ancestors were frugal, unambitious, but deeply religious Pennsylvania and Ohio Farmers and, with the exception above noted, none were distinguished in public life.

The mother, Nancy Morrow, was the daughter of Thomas Espy, a neighboring farmer. She was the neice of Prof. James P. Espy, author of the "Philosophy of Storms." The latter was a scientist of note, who, through his words of encouragement, exerted a personal influence upon his grand nephew.

George entered the district school at the age of six years

which he continued to attend for nine years, becoming the most advanced student, studying alone subjects not usually taught in such schools, as Algebra, Geometry, and Ray's Higher Arithmetic. There was at the boy's disposal the leading agricultural and other journals of the time and he also had unusual access to good books of a general character, all of which he read largely and which, doubtless in a measure, account for his tremendous habit of reading in after years.

At fifteen, he entered the Maineville Academy, situated three miles from his home, to and from which he walked daily. This Academy was one of the best of its class and was, at this time, at the height of its prosperity. He attended most of the terms until he was twenty, being interrupted two winters by teaching school. His brother says, "He studied Algebra, Geometry, Plane and Spherical Trigometry, Latin, German, with a beginning in Greek, some Ancient History, Mental Philosophy, Natural Philosophy, Chemistry, Geology, and Astronomy. In after years, he could recall little of intelligent interest in any branch but much in certain special problems arising from time to time. He selected his own studies and did not burn much midnight oil, yet he was not an idle student and he probably derived much more benefit from the Academy than some others who were more laborious. He was an attentive, rather than a hard student and he became an apt rather than a profound scholar. But the distinguishing characteristic of his school life was the frankness, sincerity, and honesty of purpose he ever manifested and his uniform affability. No one at the common school or Academy was more generally liked."

Professor Morrow often spoke disparagingly to the writer of his school work and intimated that he was well into manhood before he found himself. Be that as it may, the above estimate is one that was often placed upon him by the casual acquaintance in after years and is one that does not, in the opinion of the writer, do him full justice. His affability and lightness of manner, (even when laboring under the most severe mental and physical distress,) which, at all times, made him such a delightful companion, detracted from him in the popular judgment. The man with a sour countenance and without power as a con-

versationalist, often passes for a profound thinker because of the lack of ability to express such thoughts as he may have. Professor Morrow was a man of high mental power and his wide and accurate generalization showed him to be a deep thinker.

At twenty, when he left the Maineville academy, it is said that he could, with little coaching, probably have entered the third year of a western college and his thoughts turned not unnaturally towards Miami university at Oxford, Ohio. Instead of entering this college, however, he entered that school which has trained so many successful men of the past generation, the army.

During the twenty years of his boyhood and youth, many farm neighborhoods experienced the most marvelous changes that have ever occurred in the history of the world,—the beginning of those economic changes the character of which so few people seem to comprehend. The reaper took the place of the sickle and the cradle, the mower supplanted the scythe, the horse rake the hand rake, the horse fork the pitch fork, the grain seeder and drill the hand seeder, the threshing machine the flail or the practice of treading out by horses which was the custom on the Morrow farm. Improved methods of intercultural tillage took the place of the hoe; improved breeds of live stock supplanted the native stock.

No section of the United States perhaps was more progressive and enjoyed a greater prosperity at this time than did south-western Ohio, of which Warren county was the center. It was in Warren and adjoining counties that the now famous breed of Poland-China hogs was in process of formation during this time.

His father, although by no means a model farmer, was a promoter of education and public enterprises. As a boy, Professor Morrow, is said to have taken greater and more intelligent interest in farm improvements than the other boys about him. As a boy, he read the agricultural weekly with more avidity than any other newspaper, and a county fair, of which his father was a director, gave him annual holidays in which he took the greatest delight.

Professor Morrow volunteered as a private in Company C,

2nd. O. V. I. on August 17, 1861, and was in the battle of West Liberty, Ky., October 23, and at Piketon, November 9th.

In 1862, he was appointed division postmaster, a most desirable position for a private and especially for a newspaper correspondent. Although his position relieved him from the ordinary service of a private, when the lines were forming for the battle at Perryville, Ky., October 8, 1862, which was well known would be severely contested, he shouldered a musket and was in the thickest part of the engagement. A bullet passed through his arm, the shock striking him to the ground, although breaking no bones.

He returned to his post as division postmaster in December, and although his wound caused him some trouble, he was able to discharge his duty. His health, however, began to fail and upon the advice of the surgeon and his friends, he accepted a discharge in 1863. Being threatened with pulmonary disease, he went to Minneapolis with the hope of regaining his health and at that place, taught school one winter.

He returned during the summer of 1864, and in the fall entered the law department of the University of Michigan, Ann Arbor, where he had as lecturers, T. M. Cooley, C. I. Walker, and Judge J. V. Campbell, and where on Sundays, he listened to the sermons of the eloquent Rev. Dr. Erastus O. Haven.

Very soon after entering the army, he had begun writing for the Cincinnati Gazette. His letters were instantly recognized as valuable and he became and continued to be, while in the army, a regular paid correspondent of the Cincinnati Gazette and the New York Tribune.

While in the law department, he turned his ability as a writer to the field of agricultural journalism, in which he became at once successful, being in a very short time appointed assistant editor of the Western Rural, then a new agricultural newspaper at Detroit. Although he had definitely abandoned the law, he returned to Ann Arbor, without interruption to his editorial work, and graduated in 1866.

It was in Detroit that he met Miss Sarah M. Gifford, sister-in-law of his pastor, Rev. John P. Scott, D. D., of the United Presbyterian church, to whom he was united in marriage on

April 11, 1867. She was an accomplished lady, a loving wife, and a tender mother, who was fortunately spared to solace him the last days of his life.

The Western Rural soon became one of the leading, if not the leading journal of its class, in the northwest. The editor and proprietor gave his chief attention to the financial part of the paper, and the chief editorial work, in all its departments, fell upon assistant editor Morrow. He felt the journal succeed under his touch, and becoming ambitious to manage as well as edit an agricultural journal, he induced his eldest brother, David M., then residing at Eaton, Ohio, and who had been previously superintendent of the Eaton & Hamilton railroad, to form with him a partnership for the purpose of purchasing and publishing the Western Farmer of Madison, Wis. That the Western Farmer was well conducted and ably edited there is good evidence, and that the paper did much good there is no question, but it was not a financial success and in 1875 was discontinued.

During the five years that he spent at Madison, he formed some of the strongest friendships and some of the pleasantest recollections, but here also he experienced the most distressing difficulties of his life. Here he lost a child and namesake, to whom he was greatly attached, and amid the financial embarrassment of the paper, for which neither brother can be justly blamed, his brother died. He never tried to escape the obligations of his brother and declined to take advantage of the law of bankruptcy, which was a recognized practice at the time. When questioned with regard to this, he said simply, "My brother would have done as much for me." For years after, he lived with rigid economy and performed much drudgery outside of his professional duties to get money to pay his brother's and his own debts in full. Few people ever knew the solicitude and anxiety that Professor Morrow labored under for ten or twelve of the best years of his life. This may astonish many, who remember this affable, hopeful man of sunny disposition, who always had a kind and helpful word for every one.

He returned to the Western Rural for one year, when he was called to the chair of practical agriculture at the Iowa Agricultural college, at Ames, Iowa, in March, 1876.

His writings were characterized by timeliness, conciseness, and fair-mindedness. Many of his expressions were epigramatic. His writings for the press by no means ceased after he occupied the professorial chair. In fact, he became subsequently even more widely and favorably known as a contributor to all classes of agricultural literature. In a public address, a prominent man once remarked, "I always look for the articles signed by G. E. M., because I know they will contain something good."

On live stock matters. he was a recognized authority. His conversation and fair-mindedness did much, doubtless, to allay the bitter feeling then so rife among the champions of the different breeds of live stock.

While he was widely known as a writer, few people knew what a large amount he wrote anonymously, even in these later years. The editorial work of the Breeder's Gazette in 1881-2, during the first year of its existence, was largely done by him, although he was heavily burdened with other work and it had no small influence in the immediate success of this unrivaled stock journal. This is but one of numerous instances personally known to the writer. He afterwards recognized that this had been a mistake, but it can scarcely be said that he seriously regretted it.

During the ten years that he was engaged in agricultural journalism, he not only used the columns of the press to promote agriculture but he used his personal influence, becoming a leader in organizations devoted to this calling and, in this way, acquired practice in extemperaneous public speaking. His directness and conciseness of expression, coupled with his ready memory, soon enabled him to become an effective speaker.

At the close of a pleasant and successful year at the Iowa Agricultural college, he became professor of agriculture in the Illinois Industrial university, now the University of Illinois, beginning January, 1878.

It was in the manifold duties of this position, in the opinion of the writer, that Professor Morrow did his greatest work and left an impress that will last the longest. It was a position suited to the capacity of an agricultural writer and public speaker and with quick perception, he saw its latent possibilities

and with tact, caution, and judgment, began their development. Although the manifold duties of that position tasked his physical strength to the utmost, he always met the duties without complaint and performed them with devotion and success. As a teacher, he presented this pioneer subject with great skill and in a manner to arouse interest and to develop the reasoning capacity of the student. Professor Morrow was not a task master. He could and did inspire but he could not drive the hopelessly idle to work. He guided the able and enthusiastic student with skill so subtle as to take him long years to appreciate it fully, but the incapable or the indolent did not receive the mental training that an able task master could give. He never spared himself to serve the student, who sought his services and many such have, doubtless, received as much or more instruction outside the class room as in it. Professor Morrow possessed a vast fund of information concerning the details of his speciality, gathered in part by keen observation and in part by long intercourse with men and books, but, in part, gathered, one is almost tempted to say, through an indefinable sixth sense that some successful men seem to possess.

As before intimated, he was a great reader. He read with great rapidity and had a very retentive memory. This information was never apparently systematized and presented in any pedagogical order and sometimes its presentation was apparently marred by a lack of preparation due to stress of other duties, or physical inability, but somehow the information was imparted, and the student in after years, finds that he has retained it.

In 1878, the university being divided into colleges, he was elected the first Dean of the College of Agriculture.

In 1881, the university dispensed with the farm superintendent and he voluntarily took charge of the two farms, a stock farm of 410 acres and an experimental farm of 270 acres. He was, at this time, lecturing two hours daily to his classes. Only those who know the situation of the class room and the two farms can realize the mere physical difficulties attached to personal supervision of these farms. In explanation, it may here be recalled that twenty years ago a professor of agriculture was locked upon as a mere theorist. He had standing neither as a

scientist nor as a practical man. Professor Morrow did more, perhaps, than any other man to break down the prejudice then existing against a professor of agriculture, both among the ignorant and the educated, and to bring the position to its proper place and influence.

One reason for accepting this additional burden was to demonstrate that a professor of agriculture could be practical and another reason was the difficulty of getting, at that time, a farm superintendent, who could understand the motive with which farms of this character should be conducted.

Professor Morrow took great interest in the farm problems that arose from day to day and attended to the minutest details in the larger and varied production of the farms, devoting many hours of work each day to them. Later, when it became possible for him to turn over the details of this work to others, he kept in close touch with it. The breeding and feeding operations of the farm were numerous and varied and many of the breeds of live stock were kept, the main breed, however, being shorthorn cattle. Considerable numbers were sold at private sale and for a number of years there was an annual public sale, either alone or in connection with neighboring breeders.

Professor Morrow entered with enthusiasm into the rearing of improved breeds of live stock and into the problems connected therewith. He was, at all times, thoroughly acquainted with the individuals of the herds and could usually give the name and breeding of each without reference to records or marks. Considering his many other duties, this always seemed to the writer unusual.

It was about this time that I first met Professor Morrow. The long walks afield and to neighboring farms with him, will always remain among the choicest recollections of my life. His conversational powers never seem to lag. He was as remarkable as a story teller as Abraham Lincoln, whom he resembled in many other ways. His stories usually enforced some point and his conversation was always helpful and elevating. An agricultural professor and an agricultural student naturally conversed much about agriculture, though his conversation covered a broad range of subjects, including the topics of the day, in

which he always took a lively interest. His reading and interests were world wide and to his favored companion he always gave freely. Fortunate, indeed, was the young man who was brought under his influence.

Upon the establishment of the Illinois Experiment station, under the Hatch Act, in 1888, Professor Morrow was made its first agriculturist and a member of the board of direction of which he became president in 1891.

Professor Morrow, however, considered that his chief field of usefulness was in the cause of agricultural education rather than in the field of research. During the thirty-four years of his active professional life he devoted himself to this cause. As a writer of power for the agricultural press, as a public speaker, as a class-room teacher, and as a conversationalist, he constantly promoted it. I doubt whether any man ever accomplished more for the cause of agricultural education by his individual intercourse with men than did Professor Morrow. His conservative estimate of what had been and was being accomplished, and his constant hopefulness for the future, did more to bring agricultural education into repute among educated men than did the more extravagant statements of others. It was as a promoter of the cause of agricultural education that Professor Morrow did his great work.

In 1885, Professor Morrow, in his report to the Regent, said: "Concerning that which I have always recognized as my chief work here—giving instruction in agriculture—nine years' experience and pretty wide observation convince me that, for some little time to come 'Mahomet must go to the mountain.' The number of students in the agricultural course increases but slowly. There is, however, a distinctly marked increase of appreciation of instruction in other ways. Answering letters of inquiry on agricultural matters makes serious inroads on my time—gladly submitted to. It has been gratifying to see recent informal bulletins of moderate length copied,—and properly credited to the university, by many papers—some of large circulation and influence. It does not seem that the time has gone by when addresses before agricultural meetings have lost their influence. Within three months invitations to take an active

part in eight agricultural meetings, either state or national, have come to me. The work is exhausting but I believe I can do good for the cause of agriculture by accepting such invitations whenever it is practicable.

There is widespread and rapidly growing interest in agricultural experimentation. As always, so now, I insist that in the proper work of the college of agriculture, experimentation is, by law, made subordinate to teaching what is known. I have always felt that my first duty is to my classes, however small they may be. There is something of unreasonable expectation and belief as to the ease and cheapness with which valuable agricultural experiments can be conducted. But no one goes beyond me in my appreciation of the need and value of careful experimentation in agriculture, nor in willingness to do what I can in this work."

This expresses, in his own characteristic language what he considered his own chief field of work, and was an early warning that valuable agricultural researches would prove difficult and expensive.

During the eleven years prior to the establishment of the Experiment Station, many experiments were conducted—more, indeed, than would now be thought possible with the limited assistance at his disposal. It is true that Professor Morrow had neither the time nor the taste for systematic detail necessary to the highest research work, but had he had both, his keen sense of the paucity of the evidence would have prevented him from publishing much of it.

While, as before stated, he gave the management of the farm his personal attention, when the Experiment Station was organized he was content to leave the details of the experimental work to others, but he always kept in touch with it and always exercised a directing force.

In view of the impatience that had sometimes been shown because more in the line of research had not been accomplished, it is only proper to show that when opportunity came, through the Hatch act, for systematic experiment work, Professor Mor-

row showed ability, both in organization and in the accomplishment of results.

During the six years from May, 1888, to August, 1894, the department of agriculture of which he was the head, reported for publication 533 octavo pages of results, which was 58 per cent. of all the matter reported by all the departments of the station.

There is also accumulated and placed on file a large amount of additional data for publication. While these results contain nothing, perhaps, of a sensational character, they are of good repute among experimenters and they have gone far to establish many facts concerning plant and animal production. There is not within the limits of this sketch space to enumerate these experiments. These results were accomplished with little but his own wide experience as a guide and with his assistants to train.

In reporting the experiments for publication, Professor Morrow was always disposed to give the briefest summaries of his results. This was partly due to his newspaper training and to his habit of mind that made him so successful as a newspaper man but it was also due to the feeling that the results could not be considered conclusive until they had been long continued and not even then because of the possible sources of error should they be dogmatically stated. In this work, as in all his relations with men, he always insisted upon giving full credit to the work of others.

After Professor Morrow had served the university nearly eighteen years as professor of agriculture, seven years of which as an agriculturist to the station and three years as president of the board of direction, he severed his connection with the university of Illinois on September 1, 1894. After his resignation, he continued on the most cordial relations with the officers, faculty, and students of the institution, ever manifesting his deepest interest in the success of his former department and of the university.

It is worthy of note, that the board of trustees passed resolutions upon his resignation, which said in part: "He has continuously performed his very many duties of his responsible office with conscientious fidelity and widely acknowledged ability.

We, the Board of Trustees of the University of Illinois, do express to Professor Morrow our high appreciation of his upright, manly character and of his signal services to the cause to which he has devoted his professional life with and without the University."

During his recent illness the Faculty of the University of Illinois, learning that his illness was serious, by unanimous action sent him at intervals packages of flowers, the first of which was accompanied by a letter of sympathy and esteem from the President.

For the first time for thirty years of active professional life, Professor Morrow found himself relieved from set duties. He had long had plans for the preparation of a series of agricultural books, one of which he had planned and published in joint authorship with the writer in 1890. He, at once, began to plan for the writing of these books, and took up with renewed vigor his writing for the agricultural press. During this time he wrote the article on American Agriculture for that notable work, "One Hundred Years of American Commerce," edited by Chauncey Depew. These plans were soon frustrated, however, by his election, in July, 1895, to the Presidency of the Oklahoma Agricultural and Mechanical College, at Stillwater, Okla., entering upon the duties of President of the College, Director of the Station, Professor of Agriculture, and Agriculturist to the Station in August, 1895.

Professor Morrow's administration of this institution was so successful that, in the opinion of some, it was the greatest and crowning work of his life. Both faculty and students united in praise of his services to this institution and to the cause of higher education, in token of which there was unveiled in the College Chapel, on January 5, 1900, a portrait of ex-President Morrow, which had been purchased by the faculty and students.

Soon after entering upon his duties in Oklahoma, Professor Morrow, who had never been robust since leaving the army, perceived alarming symptoms of disease, which were finally diagnosed as the fatal leukemia, for four years, he baffled with the disease, knowing full well what was in store for him, but finally on June 30, 1899, he was compelled to retire from the

college. He removed at once to Paxton, Ill., where he spent the last few months of his life on his own farm amid comfortable surroundings, where he was tenderly cared for by his wife and two daughters and where he was visited by many of his former associates in the University of Illinois and his friends throughout the State.

"Few persons," pertinently states his brother, "have taken so great an interest in and retained their interest for so long a period in industrial fairs, or have attended so large a number of exhibitions for the encouragement of the Agricultural and Mechanic Arts as George E. Morrow."

From the day when as a lad, he first visited the county fair at Lebanon, Ohio, until his death, he was a great believer in and promoter of associated efforts of all kinds.

During his residence in Wisconsin, while editor of The Wisconsin Farmer, he became secretary of the Northwestern-Dairymen's Association, the Wisconsin State Horticultral Society, and the National Agricultural Congress. In the winter of 1870-1, he was a prime mover in the organization in Wisconsin of a State Agricultural Convention and of county and local farmer's meetings for instruction in Agriculture, out of which, doubtless, grew the State system of Farmers' Institutes.

During his connections with the University of Illinois, he was tireless in the promotion of farmer's institutes and agricultural conventions and exhibitions. In January 1878, a Farmer's Institute was held at the Illinois Industrial University with speakers from a distance, which the Regent reports to have been well attended and highly appreciated.

In 1876, Professor Morrow obtained a leave of absence from the Iowa Agricultural College to attend the Centennial in Philadelphia. In 1879, he visited Europe largely to see the Royal and Highland Agricultural Shows and again in 1889, to see the same shows and the Paris Exposition. He took an active interest in preparing exhibits for the New Orleans Cotton Exposition in 1885, which he attended ; And again for the World's Columbian Exposition at Chicago in 1893, at which he spent much time in visiting all departments but oddly, as it has been remarked although to the writer there is nothing odd about it, he spent

most of his time in the live stock and fine arts departments. He took a great interest in some of the numerous Congresses which met in connection with the fair, serving on important committees.

The first year Professor Morrow was connected with the Illinois Industrial University, namely in December 31, 1877, in a communication (see Transactions Department of Agriculture, Illinois, Vol. XV, 1877, p. 151) which was presented to the Illinois State Board of Agriculture, he recommended the holding of an annual Fat Stock Show at Chicago. This was at once reported upon favorably and $2,000 appropriated for premiums for the holding of a Fat Stock Show in December, 1878. The exhibition, carried out upon the lines laid down in Professor Morrow's letter and in which he continued to take great interest, became the greatest exhibition of its kind in the world. In this connection it may be stated that in 1889 he was elected secretary of the Illinois State Board of Agriculture, which honor he declined.

Professor Morrow was in great demand as a public speaker at national, state, and local associations devoted to the cause of agriculture. While never attempting to be oratorical, he was an effective and pleasing speaker. No other person connected with the University of Illinois was called upon so often to address public gatherings, and none was more acceptable than he. His addresses were seldom written, but the outline was usually thought over and sometimes jotted down during the hour previous to the lecture. He generally spoke in a conversational tone, in simple but dignified language, which, while he would be perfectly understood by the most unlettered, appealed no less strongly to the most learned. He was never sensational in his statements and cared little for originality, but he always had a message for his hearers.

In 1894, just after retiring from the University of Illinois, he was called upon to preside at the meeting of American Agricultural Colleges and Experiment Stations at Washington, and to deliver the president's address. Professor Morrow forcibly called attention to the lack of pedagogical methods in teaching agriculture, which subject has since received such prominent consideration by the Association. At this time a gentleman,

whose name cannot, for obvious reasons, be mentioned, but whose opportunity for knowing and judging, every one would recognize, stated to the writer that, taken all in all, he believed Professor Morrow to be the ablest man of his profession.

No biographical sketch of Professor Morrow would be complete without some reference to the religious aspect of his life. In his youth, he became a member of the United Presbyterian Congregation of which his parents were members and he afterwards joined the Presbyterian church, in which he continued until his death. His devotion to duty was here as complete and his activity as great as in his professional life. As superintendent of the Sunday School and as ruling elder, he took an important part in the councils of the church. He occasionally spoke from the pulpit. In 1892, he was a delegate to the General Assembly of the Presbyterian church at Portland, Oregon. In religious matters as elsewhere, he was loyal without being partisan, and he ever sought by precept and example to induce others to abide in the faith so dear to his own heart. He set a standard of conduct and action for himself which would probably be considered conservative and narrow, but this he did not exact of others. While rigid in his own religious views he was tolerant of the view of others and he recognized by his daily conduct that to serve was the essence of all true religion.

THOMAS F. HUNT.

The following was adopted at the New Haven meeting of the Association of American Agricultural Colleges and Experiment Stations, November 15, 1900:

George E. Morrow, LL.B., A.M., was ten years an editor of agricultural newspapers, twenty-three years Professor of Agriculture,—eighteen years with the University of Illinois,—six years the leading spirit in the Illinois Agricultural Experiment Station, four years President of the Oklahoma Agricultural and Mechanical College and Director of the Station of that institution. These positions he filled with great power and fidelity.

He was a frequent and honored attendant upon the meetings of this Association, and was in 1894 its presiding officer.

Of the many activities of the generous life of President Morrow, the cause of Agricultural Education lay nearest to his heart. As a teacher, as a public speaker, and in his intercourse with men, he maintained firmly, but without exaggeration, his faith in the ultimate success of this cause. The good which he accomplished for Agricultural Education in its pioneer days was his greatest work.

Professor Morrow was one of God's noblemen, an inspiring teacher, a devoted and true friend.

This Association records its gratitude for, and its appreciation of his wise counsels and devoted services to the ends which this Association strives to attain.

"Let us remember the debt of gratitude due from the University and the State to the memory of this patriotic and persistent soul. For he kept alive through the night of stormy darkness a smouldering fire which but for his waking anxious watchfulness, would have been quenched in an hour. "What a trivial little fire," we often said to him; "how little heat, how little light; why bother yourself so much to keep it going? It is a bad night for fires, don't you see? No one wants this one; why not let it go out?" But his faith was firmer and finer than ours, and he kept it alive as religiously as if it was the spark of his own life that he was nursing. And by and by the dripping clouds cleared away, the morning dawned, the sun arose, and a strong morning wind blew up the smoking embers to a sudden mounting flame, where but for his faithful hand it would have blown across a bed of sodden ashes only. * * * *

"We may put whatever name we choose on the corner-stone of the great new building rising yonder, but to those who knew him and know the facts of his career, that name, with whatever letters we may spell it, can only read, George Espy Morrow." —Quotation from address delivered by Professor S. A. Forbes at a memorial service, University Chapel, April 8, 1900.

Agricultural Building, University of Illinois.

THE NEW AGRICULTURAL BUILDING.

By H. C. Schuppel, Class of 1903.

To the south of the University group, between Mathews and Burrill avenues is our new Agricultural Building. This, the newest, but not the least of our buildings has the appearance of one large building; but is, in reality a group of buildings connected by corridors enclosing an open court, the main part having three stories, and each of the three wings two stories. It is very substantially built throughout, being Bedford limestone to the base of the first story window, and the remaining portion Brazil paving brick, with slate roofing. The trimmings and cornices are of buff terra cotta. The tablets which contain the inscriptions "Industrial Education Prepares the Way for a Millennium of Labor" and "The Wealth of Illinois Is in Her Soil, and Her Strength Lies in It's Intelligent Development," are also of buff terra cotta. These inscriptions are on the left and right of the main entrance respectively, and just over it we read "College of Agriculture" which is constructed of the same material.

The building is entered from the front through two doors which lead into vestibules. The doors are heavy oak, and the vestibules finished in oak, with Mosaic floors. From these we pass through swinging doors into the main hall. Directly in front of the main hall opposite the main stairway is the general office, consisting of the lobby, which is in front and separated from the general office by a railing; and back of the general office is the Faculty Room, Dean's Private Office and Director's Office. The wood work at the main entrance and in the general and private offices is oak, the Faculty room having an oak seat with ornamental carved ends and arms which adds much to the appearance of the room. In the general office on either side of the

main entrance is a bulletin and stationery file, and beyond the one on the left is a fire proof vault for the storage of records, etc. The general office is one of the principal features of the first floor of the main building, being convenient and well adapted to the purpose for which it is intended. The general office is separated from the main hall by an oak partition, with heavy plate glass on either side and an open passage way in the center. Immediately under the main office is the Mailing Department which has a cement floor and may be entered from the general office by a private stair, or from the open court on the outside.

The front stairway in the main hall is made of oak throughout and extends from the first to the third floors. There are also two side stairways of the same material. Passing down the corridor to the right of the main entrance we see the Horticultural Class Room, Laboratory and Office and a large room for mailing, storing, etc., on our right, and Agricultural Experiment Station work room, agricultural and horticultural seed rooms and toilet rooms on our left. Returning through the corridor to the left of the main hall are the Animal Husbandry seminary, lecture room, office and work room and Dairy Husbandry lecture room on our left. The Dairy Husbandry office and bacteriology rooms, Experiment Station store room and seminary are on our right. Directly in front of the main ball on the second floor we pass into the assembly room, Morrow Hall. This room including the gallery is made to accomodate five hundred people and is for the benefit of such meetings as the State Horticultural Society, Corn Growers' and Stock Breeders' associations, and the Institutes. The wood work of this room is poplar painted white. It is lighted with gas and electricity.

Passing back into the main hall and down the corridor to the right we see the Economic Entomology rooms, and Farm Crops seminary and class room on our right, and Farm Crops laboratory and office, toilet and cloak rooms, and the Agricultural Club room on our left. Passing back through the corridor to the left of the main entrance we see the Agronomy class room, office, and work room, and Soil Physics laboratory on our left and Soil Bacteriology office, ladies' toilet and cloak rooms and Womens Club room on our right. The principal features on this

floor are the Club rooms and Morrow Hall which are well lighted and ventilated, and are convenient in every respect. From the main hall on the third floor we find the entrances to the gallery of Morrow Hall. Down the corridor to the right are the photo and blue-print rooms, lecture room and Horticultural museum on our right, and Horticultural seminary, work room, herbarium, class room, and office on our left. To the left of the main entrance on our right are the Veterinary Science office and lecture room, and Experiment Station laboratory and office; and on our left are the Experiment Station special laboratory, Dairy Husbandry storage room, Dairy Husbandry museum and Veterinary Science seminary. From here we pass by the side stair to the first floor. The class rooms of this building are all large, well lighted and ventilated, and furnished with slate black boards. The brick walls on the interior are of pressed brick; all wood work in hard oil finish, with solid plaster partitions between rooms.

Turning to the right from the main corridor we enter the corridor which leads to the dairy building. This is occupied by the dairy department on the first floor and household science on the second. We enter this building through a short hall. From this we pass into the cheese room, which contains the cheese making vats, ripening vats, etc., which are used in the making of cheese. On the left of the cheese room are the cheese curing rooms, refrigerating room, engine room and wash room. The engine room has a High Art forty horse power engine and a three ton Barber ice machine used in manufacturing ice for the domestic science department and the cooling of the creamery section. The separators, testers and all the apparatus can be run by steam, which is transmitted to the building from the central heating station through high pressure steam pipes. This is a very economical plan because of the equipment at the central heating station, and by this method all dirt and dust is kept away from the dairy department.

On our right after passing into the separating room, we see the weighing room. This portion of the creamery is built on the gravity plan; but the pumping system can be used if desired. From here we pass into the creamery room, which occupies the

north end of the building and contains some of the modern separators, churns, pastuerizers, etc., and although the dairy department, as well as other departments, is greatly hampered because of the lack of appropriations, thus far all equipment has been of the latest improved kinds obtained at reasonable cost.

Passing back through the cheese room to the hall we ascend the stairs to the second story occupied by the domestic science department. In going down the corridor, on our right are household science library, dining room, kitchen and laboratory and class room, office, lockers and toilet room on our left. The class rooms of this floor are large and well lighted with solid plaster partitions. All wood work is of Georgia pine, with hard oil finish.

Returning to the first floor, we pass into the main corridor to the left and then to the right again into the animal husbandry building. On our left are the veterinary office and operating rooms, and at the end of the corridor, we pass into the stock judging room. This large roomy apartment has a tan-bark floor, is well lighted and heated, and is devoted to the use of the students for judging horses, cattle, sheep and swine. In the second story of this building is the dissecting room, a store room, attendants' room and laboratory. Retracing our steps to the stock judging room, we pass out the south entrance and enter the Farm Mechanics building or building D.

This is occupied solely by the machinery department. At the north end of the first floor is a large room for the farm and horticultural machinery, and at the south end a repair shop and locker room. In the second story is another large room devoted to farm and horticultural machinery. with work rooms to the south.

Passing out the south entrance, we come to the green house. The brick portion of this is 22x48 feet and the glass 41x120. The palm house occupies the center of the latter, and the horticultural department has the east wing, which is 41x70 feet, while the agronomy department has the west wing, 28x41 feet. This is used in the testing of seeds of various kinds, and varieties of grains and plants for vitality, moisture requirements, etc. The brick portion is used as a pot house for both

departments, and the basement under it is used as a store room. This green house is situated about five rods south of the south wing, and is separate from the rest of the building. It is the smallest, but by no means the least important part.

The buildings are lighted by gas and electricity, and are heated by steam from the central heating station. The gas pipes, electric wires and steam pipes enter the building through a tunnel, which connects with the central heating station. The tunnel is six hundred and fourteen feet long from the chemical laboratory, which is only about half the distance to the central heating station. The tunnel is six by six and one-half feet, with cement floor, brick wall and arched top. The steam for the heating is carried from the central station through a ten-inch main, and is so arranged that it may be shut off from any one building, all the buildings, or any section of a building.

The buildings are constructed on the "mill construction" plan—the beams above being heavy and exposed, and the walls between the compartments "solid plaster" partitions. There are fire stacks on each floor for use in case of fire. These are three inch pipes connected directly with the city water-supply, and they can be turned on at will. To these hose can be attached and directed on fire in any part of the buildings.

All exposed piping and radiators are finished in silver bronze. There are five freight elevators in the group of buildings—two in the main building, and one in each wing, which are hand hoist, with a capacity of one thousand pounds, and are used in the hoisting of freight and stores to the upper stories.

The wood floors are narrow quarter sawed Georgia pine, while the floors of the Dairy and Machinery buildings are cement, and of the stock-judging room tanbark. All the out side doors are of heavy oak, and all stairways of oak. The main building is about 241x90 feet, and the connecting corridors forty-two feet long. The three wings are each 45x116 feet. The entire building occupies a floor space of a little over two acres, has nearly two hundred rooms, and is over a quarter mile around. The entire cost of construction is one hundred and fifty thousand dollars. The building was begun in 1899, and is now completed. It is the largest building in the world devoted solely

to agricultural education, is the pride of the state of Illinois and we feel sure that ere the first decade of the New Century is passed the College of Agriculture of the University of Illinois will lead all others.

For a moment we stand on the threshold,
  And consider the rooms of the past,
When about to enter this mansion
  As it stands here completed at last.

Farewell we bid ye dark cellars,
  Where Field Crops and Physics were taught.
Farewell to the open air Clinic
  Where cases for treatment were brought.

Farewell to the barns of the live stock,
  Where the cattle were judged in the stall.
Farewell to the dungeon where Doctor,
  Long taught in the Engineer's Hall.

Now amazed we stand at her portals,
  As we gaze down the corridors bare;
Each leading to other departments,
  For "Learning and Labor" to share.

But a voice seems to break the deep silence,
  In a tone so gentle and clear:
Oh welcome! my sons, and my daughters;
  Come, enter with faith and good cheer.

FRED W. LADAGE, '03

THE MODERN FARMER.*

By E. T. Robbins, B.S., Class of 1900.

We are on the rising tide of the most important educational movement of recent times. During the last half century agriculture has changed from an art to a science. Aided by the older natural sciences, urged by the demands of progressive farmers, the investigators of agricultural problems have disclosed important facts and principles with a rapidity which has now expanded the available knowledge of agricultural technique beyond the compass of any one man's life experience, or of his study.

Fifty-five experiment stations in the United States alone, are wrestling with the problems of science which confront the farmer of today, and fifty-eight agricultural colleges and schools are offering to future farmers the advantages of this progress. The great educational movement thus inaugurated is the natural out come of the general recognition of the value of practical education—education designated not only to give one the broadest and most joyous life, but to fit him as well for the successful discharge of its industrial duties.

Time has been when even the farmer himself did not realize any special need of technical college study, but the conditions which fostered this feeling are rapidly passing. The same general progress and competition which are encompassing success in every other industry are now as effective in agriculture. The industrial efficiency of every man is becoming increasingly dependent upon his technical knowledge and his renumeration depends still more fully upon the ability with which he meets the great complication of duties and business.

*Valedictory address, Class of 1900, University of Illinois.

Aside from this, agriculture presents intricate problems peculiar to itself. Merely contemplate the vast natural forces with which the farmer deals. The energy which the sun expends upon the land is about 500 times as great as that which is necessary for its cultivation. If the labor of man's institution is wisely directed, this sun force may be fully utilized in producing valuable crops; otherwise it may actually impoverish the land. The farmer's labor is only a small factor in direct production, but as a directive agency of sun-energy its effect is tremendous. But the farmer's productive capital—the soil—is not a mere machine, run directly by sun power in manufacturing food products. Its susceptibility to light and heat depends upon chemical and biological phenomena of the greatest importance. The modern farmer is compelled to study these, and so to adjust his cultivation and his crops, his sales and purchases of products, as to conserve fertility and maintain the other necessary conditions of soil productiveness.

During the epoch of pioneer farming these conditions could be and were disregarded, for new land was plentiful and cheap. That era has now passed in the east, and in Illinois, and even in the far west, leading farmers are realizing that successful agriculture now depends upon economical methods. True, the change is not yet complete in either section, but those who have not accepted it, are dropping out of the class of those who are really feeding the world, and are barely feeding themselves. When Sir J. H. Gilbert, the great promoter of scientific agriculture in England, visited the United States in 1893, he exclaimed that if his country had our stock of soil fertility, and a climate that would grow Indian corn, we could not compete with her in the world's markets. Why? Because we have kept our products on the markets, not by business management, but by our natural advantages of climate and crop and extravagant use of our soil fertility! We have been drawing upon our capital for our income. It takes no special training to be able to do that. Now, with reduced soil capital, and the result that smaller crops are obtainable from the same land, even though a greater expenditure of labor is necessary, the time has come when thought put into farming will yield enormous re-

turns. The process of natural selection is working changes in the condition of the farming classes. Those who persist in the old regime, are being relentlessly out done by those who are adopting their methods to demands of present economic conditions.

Contrary to a prevalent idea, the demand for farmers is increasing. In every new country agriculture and mining are the principal and almost the only industries. With the influx of inhabitants comes an increased demand of society for comforts and luxuries, and the consequent development of other productive and commercial enterprises. This development has been extremely rapid in the United States during the last 30 years. The history of our great manufacturing and transporting industries reads like a fairy tale, and their prodigious growth has given an outlet to the surplus numbers of workers in agriculture. The very general movement of young men of energy and ability from the farm during this period, has thus had a natural and logical cause in the existing economic conditions. It is not at all a lamentable movement. It was absolutely necessary in order that equilibrium of prices should be maintained and that all men might have profitable employment. But its results may be as disasterous as those of the conditions it obviated. The movement from country to city has been rapid and enthusiastic and its inertia is carrying it beyond its rational limits. The increase in the ratio of urban to rural population is already very marked, and various industrial conditions indicate that the existing need for the movement has now been nearly, if not fully, satisfied. In a small way, a movement from city to country has already begun. Certainly this situation is more encouraging to the prospective farmer than to any one else.

The disfavor with which agriculture as a business enterprize has, of late, been regarded by many is the result of improper analysis of certain abnormal specimens of farmers. While we may not here discuss the economic relations of the landed city resident, yet the very removal from his farm, and his frequent apathy toward city improvements, tells of itself the story of low-priced land, reckless farming, money accumulated; and then the unwillingness to attack and solve the problem of

profitable farming, as it now presents itself. His position in no way indicates any failure of agriculture fully to respond to enterprize. What shall we say, in this regard of the poor renter, of the familiar type, who is now living from hand to mouth though working at manual labor twice eight hours a day throughout half the year? He has allowed himself to be buried in the details of his physical work, so that he finds neither time nor energy for studying his business, even if he ever had an inclination to do so. He has made of himself a purely manual machine, and as such he deserves and receives the pay such a machine gets in any other industry.

When cramped conditions are found among farmers it is the rule that they are caused, not by lack of hard work, but by poor management. Such men will hold their places only until their impoverished soil and the low scale of prices set by the competition of men who are farming, not to keep from starving, but as a business enterprise, forces them to take a lower level. They either must sell their muscular energies to those who can make better use of them, or they may, in spite of their mistakes, continue as independent farmers to eke out a mere existence from the sheer prodigality of nature's productiveness.

The failures of these men reflect in the popular mind to the discredit of the rural population as a whole. Such men in city life draw low wages and fill distinctive classes; in the country they may even still be independent farmers for nature will scarcely let them starve. It is unfortunate that whatever the rural citizen may do; whether he continues year after year selling his labor at $16 a month or renting, produces little above the rent; or owning land, barely escapes a tax sale; or makes his farming a profitable business enterprise, he is in each case popularly called a farmer. Thus it frequently happens that the average or inferior specimen of the composite farmer group is disparagingly compared with the representative of the more efficient of the exclusive classes in other industries. In reality as between the rural and the urban population there is no noticeable difference in the proportion of those of high and low ability. Each group embraces extremes of ability, and charac-

ter; and the influx from the country has, in large part, supplied the city industries and professions with their best grade of talent.

To thoughtful people it should be evident that there is nothing inherent in the production of food to make the industry less responsive to the exercise of good intelligence than the production of anything else. Yet the student in agriculture is frequently confronted with this query: "If you only intend to farm, why are you throwing away your time and money studying?" This question comes alike from those who have had no experience with farming, and from those farmer's sons who either possess distinct talent for some other particular work or else have been led away by the hallucinations of supposedly more brilliant prospects. What is the trouble? Do they imagine that the farmer is necessarily a manual laborer and nothing more? They evidently do not appreciate the fact that the problems of agricultural productions have become as complicated and repay as fully for their solution as do those of any other industry.

It is also frequently asserted that there is small opportunity for young men to start in the farming business. It is true, it is a difficult matter but it is in fact still harder to start independently in most other remunerative industries. The young man, who is willing to think, need not divorce himself from the farm simply because he does not happen to own a foot of land. Of course since agricultural science is new in its development the salaried positions for men of ability on farms are as yet not numerous. But still they are not so scarce at real wages equal to those the city offers, as are the men who are ready to fill them. Again, the young farmer may start as a renter and by obtaining long time leases, obviate to a large extent the tendency to exhaustive use of the soil which most surely follows the system of annual tenures, now so prevalent in this country. Still again, he may start with capital largely borrowed. There is no reason why borrowed capital cannot be as safely invested in the farming business as in others. The predjudice against it arises from those cases in which money has in reality, been borrowed to defray expenses rather than for investment. It is

true that agriculture necessitates a large outlay in fixed capital, but it is equally true that this fixed capital the land is, if properly managed, of undiminishing utility and value.

The young man of small means can thus commence farming in any one of the three ways with good prospects of success. His business is a permanent thing. No new process will supercede it when he is old and unable to commence business life anew. The possibility of sickness or accident, and the prospects of declining years—those specters of the salaried man, do not haunt him.

Just now, the conditions are most auspicious for the farmer, educated for his work. The margin between the ordinary profits, and those which are possible is so large that the number already in the business need not give us great concern. As long as the price of farm products is sufficient to furnish a living to those whose cost of production is high, it can be made to yield a profit, increasing beyond all comparison with decrease in the cost of production. To be sure, there is now no lack of numbers of farmers; and some even think we are producing too much food. They have even gone so far as to propose schemes for limiting the worlds acreage of wheat so as to secure $1.00 a bushel for all that is produced. They have entirely mistaken the situation. It is certain that the world's stock of food is not too large. The low price of wheat is due not to over stock, but to the increased facilities for production and transportation, which enable western bonanza farmers to produce it at that price. Altho in some other lines there is a demand at high prices for more than is produced, there is, in general, no special encouragement to farmers at present in the gross demand for ordinary products. But this is not discouraging. In lines of business open to free inter-competition there is never a wide margin in favor of any one of them; but in all there is constantly a splendid opportunity for the thinker to achieve success. The most encoraging feature of agriculture is at present the increasing opportunity for the application of scientific and business methods. The wear of the soil which has gone on so recklessly during our pioneer farming, keeps everything but scientific management from obtaining undiminished yields, and

promises to all other methods ultimate soil exhaustion and failure.

Another great opportunity of the modern farmer lies in the increasing demand of the consuming public, for products of high quality and distinctive character. The horticultural and live stock industries are especially replete with such inducements. They give an unlimited field for the display of ingenuity and skill in supplying these special demands, and the effort is repaid by large profits, simply because the work cannot be done by ordinary talent.

Of course the financial remuneration made possible to the educated farmer is only a part of his compensation. Absolutely necessary as it is, it may still very properly be considered a small part in so far as it leads to more than ordinary material success. The farmer no more than any one else needs an education solely to make money. He is a farmer primarily because he likes the life it gives him. If he does not like it, he very properly chooses something else that better suits his tastes. Passing over those pleasures of culture, in literature, in art and in science, which are the legacy of every college student and which arouse and sustain high ideals and noble sympathies, there still remain most sublime enjoyments which the farm alone offers to their fullest satisfaction. Our inherent love of nature, which has made the dominant note in our literature from the old folk lore of northern Europe to the latest novel, finds no where on earth such a responsive setting as in that occupation which is essentially naturalistic. The bringing to perfection of every useful living thing is at once the farmer's business and his joy. His picture, his landscape he paints with nature's aid in living plants and animals, moving clouds and shadows and an energizing sun. It is realistic, it is perfect it is more,—it is alive! Combining with his aesthetic attitude the scientific knowledge of his living friends, the farmer makes of surroundings not a prosey and a lonesome life. They become to him sources of permanent interest subjects of the deepest thought, generators of the noblest inspirations.

How can he long for the throngs of nervous people that compose the urban populace? All their friendly auspices are

supplied by rural telephone and daily mail, by electric cars and railroads, yet they do not jostle him and worry him with their petty troubles. His spare moments are free for thoughts of higher things than the bitterest competition of human lives; his soul is open to more sublime inspirations than are given by the constant sight of anxiety and restlessness. It is true, the fullest life is possible only with the exchange of ideas and sympathy between thinking men; but rural life now furnishes adequate means for this social friendship. It is equally rigid, as a law of man's higher life, that he must have hours of seclusion, such as farm life gives, when he can rise above the details of the day and think out his own philosophy; for life's real riches lie not in what one owns, nor in what he knows, but in what one thinks.

Extract from Governor John R. Tanner's message to the Illinois Legislature.

"I recommend a continuation of the wise policy in regard to the higher institutions that has heretofore prevailed. In my last biennial message I called attention to the needs of the college of agriculture in our state university. The appropriation of $150,000 made by the XLIst general assembly in pursuance of my recommendation has, I believe, been wisely expended.

"As a result thereof Illinois will soon have the largest and most complete building in the world for its college of agriculture and experiment station. A new dignity and importance has lately attached to agriculture at the state university. The attendance of students has increased from less than twenty in regular attendance to ninety for the last year and 140 to date for the current year."

A STUDY OF INDIAN CORN

By S. F. Null, Class of 1902.

Farmers, as a rule, consider very few characteristics when selecting corn for seed. Some are satisfied to plant any corn that will grow, if it comes from a good-sized ear. Others, in addition to size of ear, take into account indentation and depth of kernel. Still others add another point or two, as size of cob and shape of kernel. But this is about the extent to which characteristics are observed by the average farmer when selecting seed. Even corn breeders, who are trying to improve their varieties by erossing and selection, and who make a business of selling seed, consider only a few of the more superficial characteristics in making their own selections. This sort of breeding results in very ununiform corn. Hundreds of so-called varieties are not distinct varieties at all, because they have no fixed characteristics. They result from indiscriminate selection and have a wide latitude for variation which constantly tends towards the undesirable.

While the best bred varieties are quite ununiform in general, they have a few constant and well marked characteristics. This is doubtless owing to the fact that the men who originated and developed them made a small number of characteristics the basis of their selections of seed from year to year. The same few points were always taken into account and the many ignored. This kind of selection by the same men for a series of years, with always the same few standards in view, has resulted in fixing a small number of characteristics peculiar to their respective varieties; and, in several cases, of such a nature as to enable one to identify the breed of corn at a glance, while in general even these types are exceedingly variable.

Until recently this method of improving corn has been considered the best, and we owe to it the development of our leading

varieties. The men who have thus originated and improved varieties of corn have rendered a most valuable service to the entire country, and especially to the farmers of the corn belt. For them we have no words of criticism. It is true that with our new light upon the subject their methods seem crude, but they used the best they knew and the best that agricultural science had to offer them.

Recognizing the need of systematic and painstaking work in this direction, the Department of Farm Crops of the Agricultural College of the University of Illinois, undertook to place corn breeding upon a scientific basis. Noting the fact that all corn is very ununiform and finding the highest development of the Indian corn plant in the dent varieties having the greatest number of fixed characteristics, it was determined to elaborate some plan by which a more uniform corn could be developed. This resulted in the preparation of a nomenclature for the use of students and farmers, shorn of technical terms, applicable to ear corn and dealing with more than sixty characteristics. A copy is given herewith.

The plan for using this nomenclature is briefly as follows. Select from as large a quantity of corn as is practicable, fifty or one hundred of the most perfect ears from which to plant a seed corn plat. Tie a tag on each ear and number it. Then across the top of the page in their respective columns place the numbers of the ears to be studied. The ears should then be taken up separately and carefully studied until each of the sixty-five points of the nomenclature has been considered. When a characteristic applies, a proper marking is made in the vertical column corresponding to the ear in hand and opposite the name of the characteristic. After finishing this work we have a complete record of the characteristics of each ear examined. From this voluminous data it is easy to determine both the fixed and the variable characteristics.

Now let the corn breeder select the characteristics he wishes to fix in his variety and plant only from ears that have the greatest number of these and the smallest number of undesirable features. Then of the corn grown from the seed thus selected he should pick his seed for the next season, applying the same tests.

Corn Breeder's Nomenclature.

CROP OF.................. VARIETY.............. .... GROWN BY..................................

CHARACTERISTICS OF EAR CORN.	NO. OF EAR.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cylindrical															
Partly cylindrical															
Slowly tapering															
Distinctly tapering															
Very tapering															
Too short for circumference															
Too long for circumference															
Even at butt															
Shallow rounded at butt															
Moderately rounded at butt															
Deeply rounded at butt															
Compressed at butt															
Enlarged at butt															
Expanded at butt															
Open at butt															
Depressed at butt															
Kernels diverging at butt															
Rows in pairs															
Kernels in rows at tip															
Flat tip															
Filled tip															
Capped at tip															
Number of rows															
Rows lost															
Narrow space between rows															
Medium space between rows															
Wide space between rows															
Kernels firm															
Kernels loose															
K. roof-shaped at one edge															
K. upright															
K. sloping															
K. overlapping at summit															
K. straight wedge shape															
K. round wedge shape															
K. square at top															
K. shoe-peg form															
K. with rounded corners															
K. rectangular															
K. beaked															
K. slightly rounded at edges															
K. with small sharp point at summit															
Round, smooth, dented															
Long smooth, dented															
Crease-dented															
Pinched-dented															
Rough projection dented															
Bridged-dented															
Crumple-dented															
Large ear-stalk															
Medium ear-stalk															
Small ear-stalk															
Circumference of ear															
Length of ear															
Breadth of kernel															
Depth of kernel															
Thickness of kernel															
Large cob															
Medium cob															
Small cob															
Rows straight															
Rows turn to right															
Rows turn to left															
Color of corn															
Color of cob															

Each year a record should be kept of the characteristics of the corn planted and from these the progress of development can be determined. It is thought that in this way comparatively uniform varieties of corn may soon be developed. It is not difficult to learn to do this sort of work, nor is it so tedious as it would seem. It is practical for all corn growers to select seed in this way for planting small plats, and many have already taken kindly to it.

In its attempt to render material assistance to the farmers of the state in the further development and perfecting of Indian corn, the College of Agriculture is not only giving attention to the selection of seed corn in the ear, but it is also conducting a series of field experiments in the interests of corn breeding to supplement the work just outlined. It is evident that anything like perfection in the Indian corn plant can never be attained without taking into account not only ear, but also the stalk, leaf and root developments, as well as the tassel and silks.

The tassel and silks are the male and female organs, respectively, and the formation of grain depends entirely upon their healthy growth and the relative time of their maturity. Recognizing these facts, and desiring to make a logical study of corn, begining with the ear and working outward, the Department of Farm Crops conducted quite a number of experiments in this division of the subject during the past summer. Some of these will need to be repeated several times before the results are given out, while a few are already conclusive. These experiments were conducted on a plat of ground comprising about three acres, on which 36 varieties of corn were grown in alternate rows. After the shoots were well out of the axis of the leaf and before the silks began to appear, large, tough, paper sacks were tied over the rudimentary ears, completely preventing pollenization. Every other day the sacks were adjusted and the strings loosened, so as to permit of growth, but care was taken to keep them tight enough to prevent insects from creeping up under their edge and carrying pollen to the silks. When anything happened to an ear which might make its value in the experiment uncertain, it was discarded.

In each of the following experiments unless otherwise

stated, the sacks were removed only once and the silks were pollenized in the manner indicated; then the sacks were replaced and left unmolested to the end of the growing season, except to loosen the strings as the ears developed.

In the first experiment the silks were pollenized soon after they came through the point of the husk and were about one inch long. From this experiment thirteen ears were procured, all very much exposed at the tip, some for more than half the length of the ear. Seven were exposed at butt and six filled at butt. This seems to prove that silks are ready for pollen as soon as they appear. It also indicates that the tip silks and probably some of those at the extreme butt are late.

In the second experiment the silks were pollenized in about the middle of the receptive period, five days after they came through the husk. From this nine ears were obtained, six of which were as well filled as average ears in the field. Three were badly exposed at tip, and one at butt, while one was well filled at both ends, showing that all the silks on this ear were in a receptive condition at the same time.

In the third experiment the silks were drying up when pollenized. They had been out of the husk from ten to twelve days. From this experiment nine ears were gathered. Of these none were well filled. All were fairly well filled at the tip and none well filled at the butt. In four the cobs were entirely exposed at the lower half of the ears. This emphasizes one conclusion drawn from the first experiment that tip silks are usually late.

In the fourth, fifth and sixth experiments the silks were pollenized respectively at their extreme ends, in the middle, and at the point of the husk, when they were from four to six days old. The poorest results were obtained from tip or end pollenization. It was found that the longest silks grow from the middle of the ear.

In the seventh experiment sacks were tied over the ears before the silks started and were not removed until the corn was gathered. As no pollen was allowed to come into contact with silks kernels did not form, and the cobs did not harden, although they grew to be of almost natural size. The silks were still ad-

hering to the cobs when they were harvested, and the stalks remained green longer than those bearing ears.

In the twenty-four experiment a large number of ears were dissected, in order to study their development. Some of these had been pollenized and some had not. The silks of the unpollenized ears retained their hold upon the ovules to the last, and were in a receptive condition from eight to fourteen days, depending somewhat upon the variety and the weather. They made an abnormal growth, sometimes protruding as much as 16 inches from the point of the husk. This showed a great effort on the part of the silks to become pollenized. On the other hand when pollen came into contact with the silks, they ceased to grow, soon became detached from the kernels, and the development of the ears was so rapid at this stage that within four days, the lower ends of the silks were often carried up the ear as much as two inches from the young kernels to which they had been attached.

In the twenty-fifth experiment the sacks were loosely adjusted intentionally, and the ears were partially pollenized by insects creeping inside.

In the ninth experiment the ears resulting from removing the sacks for 24 hours were about three-fourths filled.

The seventeenth experiment was with pollen that had been exposed to the hot sun for one hour. The resulting ears were from one-half to three-fourths filled.

In experiment eighteen pollen was used in the morning that had been collected the evening before. It produced ears that were about half filled. The last two experiments indicate that pollen may remain fresh and mix varieties of corn after being carried a long distance by the wind or by insects.

During the past summer it was found that a well developed corn tassel of any of the standard dent varieties produces from thirty to thirty-six million grains of pollen. making at least thirty thousand to each silk or kernel of corn. Detasseling experiments show that this is a great excess of pollen; also, that it requires much plant food to produce the pollen, and that when the plant food is diverted from the tassel to the ear, without serious injury to the stalk, the yield is increased. Tassels may

may be bred to be smaller if they mature with the silks. A tassel sheds its pollen for about a week. Pollen falls continuously from one variety for about two weeks, and is usually half gone before the silks appear on the same plant. The tassels and silks of late varieties are the most variable as to time of maturity. These have a greater number of barren stalks than the medium or early varieties. Many ears develop silks too late to become fertilized. Tip silks are late. Silks may be in a receptive condition from ten days to two weeks. Medium early ears are best filled. Best filled ears have a simultaneous silk development. When the silks develop unevenly the first kernels set are apt to rob the others of plant food.

AGRICULTURAL PUBLICATIONS.

By J. Orton Finley, Class of 1903.

The publications of our Experiment Stations will amply repay brief consideration on the part of most farmers. They are not, as many suppose, of use only to the professional man and the agricultural student, but most of them are intended for the farmer himself. Doubtless many are not acquainted with the nature of these publications or the ways of obtaining them, but this should not be so, as they contain much information of great value in practical work.

The United States Department of Agriculture and the State Experiment Stations have contributed much to help the farmer understand the natural laws with which he has to deal, and the usefulness of these agencies is not as generally known as it should be. Reliable information of sufficient interest and utility is put in form of bulletins and books which are available to all who will send for them to the departments where they are published.

Many agricultural papers have given some of the subjects treated considerable space in their columns, but the information

published as it is by these stations free for the asking, is in the best form for distribution, and is written in as compact and practical a manner as is possible. These circulars of information which are printed in large editions for distribution, are the published researches and experiments of the Experiment Stations whose work is to discover and make public whatever truths or principles are brought out by their investigations.

The publications of the United States Department of Agriculture are mainly of three classes. The first class comprises the Year Books, which are published annually and the annual reports of the Bureau of Animal Industry and of the Weather Bureau. This class is distributed by the Department, and by the Senators and Representatives in Congress. They are not issued in large enough editions for general distribution. They are published mainly for special correspondents and agents of the Department.

The second class of publications is made up of departmental reports and divisional bulletins, of which each bureau has its own division. Their reports, etc. are numbered consecutively as issued and contain reports and discoveries of a scientific or technical character. They are not issued in large editions, and are not for distribution by the congressmen but are given by the Department to those who have cooperated with it or rendered it some service. They are also given to different educational and other public institutions. A sample copy of this class is usually sent upon application, but the applicants are referred to the Superintendent of Documents, Washington, D. C., who has a limited supply of all the publications of classes one and two. In applying for them from this source the application should be accompanied by postal money order, payable to him for the amount of cost of printing.

The third class of publications is Farmer's bulletins, divisional circulars, reprinted Year Book articles and other popular papers. This class is printed in large editions for free distribution to farmers. They are distributed by congressmen in their respective districts and can also be obtained by addressing the Secretary of Agriculture, Washington, D. C., giving the numbers of the bulletins desired.

Every farmer and all who are interested in agriculture should address the Secretary of Agriculture for bulletin number 247 which contains a brief description of the contents of Farmer's bulletins from number 16 to 114. The following is an illustration of the descriptions of bulletins listed in this number: Bulletin Number 71—"Some Essentials in Beef Production. The contents of this bulletin are: the beef type,—the use of the score cord—beef charactistics briefly defined—selection of stock cattle for feeding—breeding type vs. the block—the types compared—excellence for the block due to inherited quality rather than feed or gain—early maturity—the passing of the heavy weight carcass—the economy of gain at different ages compared."

The department has no list of persons to whom all the publications are sent, and application will have to be made each time any information is desired. For this purpose the Department issues a monthly list of all the publications, published the previous month, which will be mailed regularly to all who apply for it, and from this list, together with the instructions for applying for them, one can select what is of interest to him.

The Department does not send documents to individuals for redistribution; but if names with addresses are furnished of persons to whom it is desired that publications be sent, the Department will mail such persons the desired information.

In each state there is an Experiment Station which is kept up by funds from the United States Government, each Station receiving $15,000 per year for the purpose of making investigations, researches and experiments in all things pertaining to the agricultural interests of the state, and publishing the results obtained. This matter is published in the form of bulletins which are numbered consecutively as issued, and are for free distribution. A mailing list is kept by these Stations, and all who have their names placed upon this list will receive all bulletins of the Station as they are issued. The Illinois Experiment Station can be addressed at Urbana, Illinois, and information of the above character obtained.

It is not within the range of the Experiment Station to do the work of the agricultural college, the agricultural press or

the farmer's institute, as its work is chiefly that of research. It is the source from which comes the knowledge that is the foundation of the teaching in the agricultural colleges.

Another factor which may do much to help the farmer in his study of agriculture is the farmer's reading courses. While these have not been taken up in Illinois, a number of the eastern states and South Dakota have incorporated them with their agricultural college extension work. In addition to recommending bulletins, a plan for certain courses in agricultural reading is laid out, on such subjects as soils and crops, live stock management and feeding, dairying, fruit culture, and others. Books are selected for this reading which clearly set forth the principles underlying the subjects. The work is under the control of a superintendent especially for this work, who makes the arrangements for supplying those who join the course, conducts the examinations, and answers questions.

In these courses the reader is under the college direction on his chosen subjects, and his reading is systematized so as to make the knowledge acquired of use to him in his farm work. The method is simple. A book on the topic chosen is sent the reader, to be read or studied carefully, and printed questions will be given him, the full answers to which are to be written out and returned with the book. These questions are to fix in mind the essentials of the subject studied. No charge is made for the books, but there is an enrollment fee of one dollar. By reading a small amount each day a course can usually be covered in about two years time. No examinations for entrance are acquired.

The importance and helpfulness of a course of the kind; when one has not the opportunity of taking a course at an agricultural college cannot be over-estimated, and it is hoped that soon all the states will adopt some such method of extending agricultural instruction to all who desire it. Furthermore, the man who keeps himself in touch with the agricultural publications is of great value to the community in which he lives. His methods of working, and his interest in the subject inspire confidence, and his influence makes him a power.

THE GROWING OF SUGAR BEETS.

By A. E. Wade, Class of 1903.

After one season's experience in the growing of sugar beets I will endeavor to tell briefly, for the benefit of those interested in this crop, how I would go about it to raise one hundred acres of beets. I will doubtless present some methods which I would change with more experience. No one can lay down iron clad rules for raising beets, or any other crop, but there are a few general rules that we must all follow. I would first select the best land obtainable, not more than one and one-half miles from a railroad station at which the beets could be loaded for shipment. The field should have been out of sod for at least two years, and should be fertile and free from weeds. I would prefer a clay loam to any other soil. It should have been in some small grain the season before, manured liberally with well rotted stable manure during the summer, and plowed about seven inches deep in the fall. In the spring as soon as it is dry enough, I would disc and harrow, and after a few days disc and harrow again, planting as soon as the soil was warm enough to sprout the seed, which would be about 50° F. I would prefer to plant after the harrow in most cases. Great care should always be taken to have the seed bed properly prepared before seeding. It is held by some that beet ground should be very loose and mellow, but my observation last season was that where the ground was most compact the beets made the most rapid growth, especially in the early part of the season. Care must be taken, however, that the soil is not settled so firmly together as to allow too great a loss of moisture, or the crop will suffer later in the season.

The cultivation should begin as soon as the plants are in their second pair of leaves, and the work of bunching and thin-

ning should generally follow at once. A good man can bunch about an acre, and a boy can thin about one-third of an acre per day. The rows being eighteen inches apart, the beets should be left about ten inches apart in the rows, care being taken to leave the thriftiest plants. Cultivation should be continued throughout the season, as this is necessary for the extermination of weeds and the preservation of moisture. Under ordinary circumstances four or five cultivations will be sufficient. The total cost of a crop of beets should not exceed $35.00 per acre.

Beets are generally believed to be very exhaustive on the soil. In regard to this I may say that an average beet crop does not take as much nitrogen from the soil as an average corn crop, but it does take more potash. As the corn crop needs a considerable amount of potash in the early stages of its growth I consider it poor policy to follow beets with corn; but on the other hand, oats do remarkably well after beets. I did, however, note several instances last year where corn did better after beets than after oats. As nitrogen is worth about 15 cts. and potash about 4 cts. per pound in the form of fertilizer, any one can readily see that it would be cheaper to supply the potash than the nitrogen.

The handling of the labor is a matter of no small importance. A manager is generally put with every fifteen or twenty bunchers, and with about the same number of thinners to see that the work is properly done. There are several methods of managing this work, and probably as good a one as any is to start the men together and have one to help out those that drop behind, thus keeping them close together. Another method is to give each man a certain number of rows. The hoeing can be managed in the same way. I would get along with as little hoeing as possible and still keep the weeds down. In pulling the beets it is the usual practice for two boys to take two rows each, throwing the beets in piles at convenient intervals with the tops all one way so that they can be topped readily.

AN EXPERIMENT IN LISTING CORN.

By Fred W. Ladage, Class of 1903.

There are different ways in which listing is practised in this country. The most common way is with what is known as a four-horse lister, which is built something on the plan of an old fashioned sulky plow, breaking a furrow about ten inches wide, and throwing the dirt both ways. It has an attachment for drilling the corn at the same operation, one and one-half to two inches deep in the bottom of the furrow. Another way very largely practised is to list the ground in the fall, relist in the spring, and follow the lister with an ordinary check-rower, checking the corn in the furrows.

The following experiment was undertaken in order to compare listed corn with corn planted in the ordinary way. It was conducted in Sangamon, Co., Illinois, on a rich loam soil, very level and well drained. Four crops of corn had been grown in succession on this field, and each year the corn had a tendency to blow down easily in late summer storms.

In the experiment eight rows, eighty rods long, were planted in the ordinary way; that is, by breaking up the ground five to six inches deep, pulverizing thoroughly, and planting with a check-rower. Then eight more rows of the same length were single-listed—the lister being run but once in the forrow—and the corn planted in these furrows with a check-rower. Three times these plats were alternately repeated, making six plats of eight rows each. All the corn of these was planted about the 10th of May.

The corn germinated quickly and all came up evenly and promised a good stand, but birds, mice, and insects begin to work on the grain and small plants. They seemed to take particular hold of the listed corn, probably because the kernels lay closer to the surface; and for the same reason the plants were more easily destroyed.

As soon as the corn sprouts began to appear the ridges of listed corn were rolled and harrowed, repeating again in about ten days. The unlisted corn was cultivated when the corn had about six leaves. Nothing was done to it until about ten days later when both listed and unlisted were cross cultivated. The unlisted corn stood then about a foot to sixteen inches high, while the listed corn was not more than half as tall, besides having very slender stems, and there was a well marked difference in the color, the latter presenting a yellow appearance, resembling corn suffering from excessive water near the surface of the soil. The corn was plowed for the last time about June 25th. However, by this time the listed corn had assumed a dark green color and the height of a man's knee, while the unlisted easily reached a man's waist.

About three weeks later heavy rains passed through that section of the county followed by strong winds, the unlisted corn took a strong leaning position, much of it filling flat, while the listed corn stood firm and erect. In a week or ten days there was scarcely a difference to be noticed in the height of the whole field.

The listed corn was fully five or six days later in tasseling and shooting, the stalks were smaller, had less foliage and the ears hung closer to the ground. The long corn worm was found more abundantly in the ears of the listed corn. When husked the listed corn was more chaffy, weighed less in the bulk, and weighed out $9\frac{5}{7}$ bu. less per acre, averaging about 46 bu. per acre.

In some sections of Sangamon county listing is practised quite extensively. Some farmers with 12 or 14 men put out a crop of from 1800 to 2000 acres in this manner. While some fields of this corn may be from fair to good over half scarcely yields anything and can therefore not be considered profitable.

Some farmers advocate that listed corn is kept clean more easily if properly cared for in the start. This, however, was not true, if anything weeds took a stronger growth after the last cultivation, owing to the fact that there was less foliage to shade the ground.

The only advantage in listing corn is, it does not take so much work to put in the crop, while if listed corn be properly

cared for as rolling harrowing and cultivating sufficiently to keep down the weeds, it requires more labor than the ordinary way of planting and cultivating. Others advocate double listing, this however is self-evident, that it will require more labor and to no advantage whatever over the old method.

Again, some farmers advocate listing for a long dry summer; this may be true to some extent, as listed corn always makes a wonderful growth during the hot and dry months of July and August. But we must also remember a plant that has been stunted in early life, can never be fully deloveped as a plant that has not been sit back in the early stage, no more than a stunted pig or calf can ever be the prime animal of the market. But the corn plant after having made a vigorous growth and been properly cultivated in the early stage, can endure considerable dry weather, as it has a much stronger root development and therefore feeds from a greater soil surface than corn which has been stunted in early life.

In conclusion I will say, while I believe that this experiment was carefully conducted, and conditions noted at proper intervals I do not see that corn listing on rich prairie soil could be considered practical either from the standpoint of profit or labor saving.

A SUMMER'S WORK ON THE SIBLEY FARMS.

By D. S. Dalbey, Class of 1902.

The department of farm crops of the University of Illinois inaugurated a new plan in the spring of 1900, whereby it was proposed to send students, during the summer months, to farms where the best methods are employed, to have them carry on work under the direction of the owners or managers of these farms, and credit being allowed for the work thus performed. With this object in view, two agricultural students, G. M. Richardson and myself were given the opportunity to go to the Sibley estate farms at Sibley, Illinois. The primary object of this undertaking was, not only to carry on original investigation in farm crops, but also to become grounded in the details of farm management. A more suitable location for any one with the above objects in view could scarcely be found.

The Sibley estate called the Burr Oaks farms, are located in the center of one of the most productive sections in the state. The estate embraces a body of land of vast extent and is probably equal in value to any entailed estate of the same extent in this country. It consists of 21760 acres or 34 sections, lies in a compact body, and is divided into 127 farms eight of which contain 320 acres, the remainder. 160 acres. Every acre is under a high state of cultivation except 60 acres of a burr oak grove which is used for pasture. The whole tract is thoroughly tiled and accurate maps of all the tile laid are kept. The land is farmed by the tenant system.

The ground and equipment for the experiments were very generously donated by the Sibley estate through its manager, Mr. Warner, who spared no trouble nor thought to make our experiments a success. We reported at Sibley on April 6, 1900

and after looking over the ground, a plan was developed which included the following experiments.

1. A test for the different methods of sowing oats.
2. Smut treatment of oats.
3. Variety test for oats.
4. Variety test for corn.
5. A test for the different depths of plowing for corn.
6. A test for commercial fertilizers.
7. Corn breeding.
8. Variety test for potatoes.
9. Methods of planting potatoes, cow peas and clover.

TREATMENT OF OATS FOR SMUT.

The object of this experiment was to ascertain the benefit derived from treating seed oats for smut with the hot water and formalin treatments. Different temperatures of hot water for killing the smut spores were also tested. The experiment included ten plats, each having as nearly equal conditions as possible.

Plat 1 was sown with oats not treated.
Plat 2 was sown with outs treated at 120° (Fah.)
Plat 3 was sown with oats treated at 125° (Fah.)
Plat 4 was sown with oats treated at 130° (Fah.)
Plat 5 was sown with oats treated at 132° (Fah.)
Plat 6 was sown with oats treated at 136° (Fah.)
Plat 7 was sown with oats treated at 138° (Fah.)
Plat 8 was sown with oats treated at 140° (Fah.)
Plat 9 was sown with oats treated at 142° (Fah.)
Plat 10 was sown with oats treated with formalin.

In treating the oats with hot water a barrel of water heated by steam was used and about a peck of oats at a time was exposed to the water for five minutes. In the formalin treatment, one pint of formalin was diluted with 25 gallons of water and the oats in a sack soaked for two hours.

The per cent of smut found was:
Plat 1 sown with oats not treated, 15%.
Plat 2 sown with oats treated at 120°, 8%.
Plat 3 sown with oats treated at 125°, 4%.

Plats 4, 5, 6, 7, 8, 9 and 10 sown with oats treated at temperatures ranging from 130° to 142° and including the formalin plat had no smut. In cutting the oats it was not found practical to cut each plat separately, so the seven plats having no smut were cut together. The yield of these seven plats was at the rate of 60 bu. per acre while the yield of the not treated plat was only 51 bu. per acre showing a difference of 9 bushels per acre in favor of the treatment. Also, there was no perceptible difference in stand between the plats treated at low temperatures and those treated at 142° or the formalin plat, showing that the vitality of the seed was not injured at the high temperatures.

VARIETIES OF OATS.

An experiment was made with 25 varieties of oats; comparing them as to growth, time of maturity and yield. Two plats of each variety were sown in different parts of the field in order to strike a fair average if any inequality in fertility of soil should exist. Each variety was sown at the rate of three bu. per acre and each was given the same preparation of seed bed viz: Disced, seeded, disced and harrowed. The oats were sown Apr. 20. On July 21, a heavy rainstorm lodged all of the oats not harvested, which probably lessened the yield of the later varieties.

The date of maturity and yields of the varieties were:

	Date of maturity.	Yield per acre.
Sibley Black (black)	July 18.	75 bushels
Calgary Gray (black)	July 18.	75 bushels
Lincoln (white)	July 18.	72½ bushels
Irish Victor (white)	July 26.	65 bushels
White Superior Scotch (white)	July 18.	65 bushels
Silvermine (white)	July 25.	65 bushels
Russian No. 2 (white)	July 25.	65 bushels
Danish (white)	July 24.	61¼ bushels
Olds' 4th July (white)	July 18.	60 bushels
Black Tartarian (black)	July 18.	57½ bushels
Iowa Prolific (white)	July 25.	56¼ bushels
Michigan Wonder (white)	July 24.	56¼ bushels
Salzer's Big 4 (white)	July 26.	55 bushels
Illinois (white)	July 26.	53¾ bushels
Early Champion (white)	July 11.	53¾ bushels
Red Rust Proof (white)	July 26.	52½ bushels
Great American (white)	July 26.	52½ bushels
Burr Oaks (white)	July 26.	50 bushels
New Alaska (white)	July 11.	50 bushels

New Zealand (white)	July 25.	47½ bushels
White Maine (white)	July 26.	47½ bushels
Alaska (white)	July 11	46¼ bushels
Clydesdale (white	July 26.	46¼ bushels
Improved White Russian (white)	July 25.	42½ bushels
Sibley 4th July (white)	July 11.	42½ bushels

METHODS OF SEEDING OATS.

Five different methods practised in sowing oats were tested. The variety used was the "Twentieth Century," a new, late maturing, barley oat. The oats were sown April 9 at the rate of 2⅜ bu. per acre and alfalfa was sown with them. On July 20 each plat was harvested separately. The methods of sowing and yields were:

Method of sowing.	Yield per acre.
Plat 1—Disced, seeded, disced and harrowed	46 bu.
Plat 2--Seeded, disced, disced and harrowed	44 bu.
Plat 3—Cultivated, seeded and harrowed	43 bu.
Plat 4—Seeded, cultivated and harrowed	44 bu.
Plat 5—Cultivated, seeded, cultivated and harrowed	44 bu.

The light yields were probably due to light seeding as only 2⅜ bu. per acre were sown and the grains being very large and heavy, the stand was thin. In all of these plats the work of preparing the ground was done thoroughly and no experiment made with putting in the oats carelessly as they often are, which probably accounts for the slight variation in yield in the different plats.

CORN BREEDING.

The object of this experiment was to improve by selection and breeding a particular variety of corn. The corn used was a number of ears of Riley's favorite yellow corn which had been specially selected by Mr. Riley himself from his own growing. The corn was planted in plats of 81 hills or 9 hills square, planting one ear to each plat and saving the remainder of the ear for comparison with its progeny. At husking time each plat was separately husked and compared with the parent ear as to type. Then the plat which showed the closest resemblance to the parent ear, or had the greatest prepotency, was saved for the stock of the next year's breeding.

As a breeder, the greatest objection to this variety is that the type is not fixed, and a great many variations occur, making

it difficult to breed it up until it conforms to a single standard, as a result the percent of prepotency was very small. The results determined were as follows:

PLAT NO.	Total number of ears grown on 81 hills.	Number of rows on original ear.	No. of ears type like original, including rows.	No. of ears type like original, except more or less rows.	Tendency characteristic—Pride of North or Leaming.	Percentage of Prepotency, including same number of rows.	Percentage of prepotency, except more or less rows.
1	115	20	2	17	Pride of North.	1.7	14.8
2	136	18	10	10	Pride of North.	7.3	7.3
3	135	20	2	7	Both.	1.4	5.1
4	127	18	10	18	Both.	7.8	14.1
5	118	18	6	7	Leaming.	5.	5.9
6	116	20	1	6	Pride of North.	.8	5.1
7	138	18	9	11	Pride of North.	6.5	7.9
8	120	20	4	8	Pride of North.	3.3	6.6
9	122	20	5	9	Leaming.	4.	7.3
10	118	18	4	11	Leaming.	3.3	9.3
11	131	16	14	16	Pride of North.	10.5	12.2
12	140	20	1	15	Pride of North.	.7	10.7
13	103	16	4	11	Leaming.	3.8	10.6
14	123	22	0	15	Pride of North.	0	12.2
15	117	18	9	24	Leaming.	7.6	20.

VARIETIES OF CORN.

Twenty-seven varieties of corn were planted and grown under equal conditions in order to get a comparison of their growth, times of maturity and yields. Two rows of each variety were planted on May 21st, dropping the hills 3½ ft. apart each way. The corn was cultivated five times, and a weekly measurement of the growth of each variety was taken.

When the corn was husked the following results were obtained :

Row No.	Variety Name.	Yield per acre in ear. Bushels.	Yield per acre shelled. Bushels.	Per cent. of shelled corn to total weight in ear.	No. lbs. cob per bu.
1	Silvermine	62.5	76.5	85.7	10.
2	Boone County White	74.	82.	78.5	15.
3	Clark Big 4	78.5	87.5	78.5	15.
4	Star White	84.	90.4	75.3	17.25
5	Blount's Prolific	92.	96.	73.1	19.
6	Burr's White	76.5	88.5	81.1	13.25
7	White Leaming	80.	88.5	77.1	16.
8	Champion White Pearl	68.5	78.5	79.7	14.25
9	White Elephant	78.5	75.5	67.1	23.
10	Silvermine J. H. B	60.	73.5	83.4	11.75
11	Silvermiue U. of I	84.5	91.	75.4	17.5
12	White Elephant E. S. F	66.5	65.5	69.3	21.5
13	St. Charles White	72.5	81.1	78.7	15.
14	Reid's Yellow Dent	74.5	81.	76.	17.
15	Pride of North Estate	67.	76.5	80.	14.
16	Yellow Quaker	45.	51.5	79.1	13.5
17	Golden Eagle	56.	64.5	80.5	14.5
18	Yellow Dent	64.	71.	77.5	15.75
19	Leaming	75.5	84.	78.3	15.
20	Gold Mine	57.5	64.	77.6	15.75
21	Golden Beauty	73.5	80.5	77.	15.
22	Mortgage Lifter	62.	69.	76.8	15.
23	Pride of North	62.	74.	82.4	12.5
24	Riley's Favorite	66.	75.	78.9	14.75
25	Burr Oaks Leaming	80.	86.	74.7	17.75
26	Maner's Yellow Dent	75.5	84.	78.3	15.
27	Minnesota Ideal	33.	39.5	84.8	10.5

EXPERIMENT WITH DEPTHS OF PLOWING.

An experiment was made testing the different depths of spring plowing for corn. Four different depths were tried viz: 3-in., 4-in., 5-in. and 6-in. plowing. Two separate plats, of an acre each, were devoted to each depth and the average of the two plats taken. The results are:

Plowed 3 inches deep—41.5 bushels per acre.
" 4 " " —42. " " "
" 5 " " —41.6 " " "
" 6 " " —40.5 " " "

From the above it would seem that the 4-inch plowing is the best the 5-inch next while the 3-inch and 6-inch plowing do not show up so well, although there is not enough difference to indicate anything final. However the results accord with theory, in that the extreme shallow plowing gave larger yields than the extreme deep plowing of 6 inches. While deep plowing in the fall is considered good practice, if practised in the spring it uses up too much of the valuable surface soil as a mulch, besides breaking off the capillarity which requires several months to be re-established.

METHODS OF PLANTING POTATOES.

The object in making this experiment was to determine the effect upon yield of planting different numbers of eyes per hill, and the effect, both on yield and time required to come up, of planting the potatoes with the sprouts turned up or down. The variety used was the Early Six Weeks, and was planted Apr. 26, giving each row the same preparation of seed bed and same covering of soil. During the growing season the same cultivation was given all.

On Aug. 22nd the potatoes were harvested. In figuring the results the total yield of each method was obtained, then the small ones were picked out and the weight of the marketable yield taken. The following results were obtained:

Method of Planting.	Total Yield.	Marketable Yield.
Row 1—2 eyes per hill sprout turned up	31 lbs.	26 lbs.
Row 2—2 eyes per hill sprout turned down	19 lbs.	14 lbs.
Row 3—1 eye per hill sprout turned up	24¼ lbs.	23½ lbs.
Row 4—1 eye per hill sprout turned down	21 lbs.	18½ lbs.
Row 5—Whole potato planted per hill	39 lbs.	25½ lbs.
Row 6—Potato with seed end cut off	39 lbs.	33 lbs.

There was a difference of five days between the rows planted with the sprout turned up and those planted with the sprout down, the row planted sprout up being five days earlier. A very perceptible difference in yield was observed both in the total and marketable yields, the row planted with two eyes sprout up yielding nearly double the amount grown on the row planted sprout down.

In comparing row 5 and 6 it is evident that planting whole potatoes one in each hill produces a large total yield but the

shrinkage when the unmarketable ones are taken out is very great. On the other hand, planting the whole potato, except the seed end, produces a heavier yield of marketable potatoes than any of the other methods tested. These differences are doubtless due to the fact that the whole potato has a larger number of eyes in proportion to the substance of the potato, than the potato with the seed end cut off, consequently the latter practice would give more nourishment to each eye than the former and the result is fewer plants per hill with larger amount of plant food furnished by the potato in proportion.

FERTILIZER EXPERIMENT.

The German Kali works of New York, furnished the fertilizer to make an experiment testing the value of the different commercial fertilizers in growing corn on our average Illinois soil, and to determine if possible the elements of fertility lacking and what fertilizer would supply the want. One part of the experiment was to try the effect of lime on the soil. The lime was applied on March 23rd at the rate of 2000 pounds per acre on half of the plats, the others receiving no lime. The fertilizers used were phosphates, muriate of potash, nitrate of soda and sulphate of potash, compounded in several proportions and mixtures. The results show no appreciable effect of the lime, on yields as in nearly every case the plats not limed yielded as much as the limed plats. The other results were hardly comparable as there was considerable inequality in the plats as to natural fertility of the soil. The highest yield however was produced from the plat on which no lime had been applied, but an application was made of acid phosphate at the rate of 600 pounds, muriate of potash at the rate of 120 lbs. and nitrate of soda at the rate of 200 pounds per acre.

COWPEAS.

Some cowpeas were sown at different times to determine the most favorable time for planting, to produce seed. Three different times of planting were tested, viz: May 11th, June 5th and July 3rd, and were drilled thickly in rows two feet apart.

As this plant is a native of the tropics, it is very sensitive to cold and will not germinate nor grow until the ground becomes

well warmed. Consequently the early planting did not make as rapid growth at first as those planted later.

We also tried sowing cowpeas in the corn just before the last cultivation, sowing the seed broadcast by hand, at the rate of one bushel per acre. This method proved very successful this year so far as a fertilizer and cover crop are concerned, as the seed germinated well and a good stand came up. The plants at first made a weakly growth, due to the shading of the corn, but after the corn dried up, the plants grew strong, making a heavy growth of vine before frost. As evidence of the value of cowpeas as a fertilizer some of the roots were carefully dug up and it was found that a large number of nitrogen tubercles had been formed, some of which were unusually large, one specimen weighing 1.224 grams.

The difference in time of maturity of the three plantings was not as great as the difference in planting, but the early planting produced a heavier crop of seed than the later ones.

About ten acres of corn was sown to clover, sowing the seed broadcast at the rate of twelve pounds per acre. The seed was covered with the last cultivation of the corn and soon germinated, but did not make much progress until the corn stopped growing and dried up, allowing the sunlight to strike the plants, and as the fall was unusually late, the clover made quite a growth and bids fair to live through the winter.

The results of the experiments given in detail above, being the outcome of only one year's work, do not prove anything from which final conclusions can be drawn. The same experiments tried another year under slightly different weather conditions might result in a reversal of some of the results of this year's experimentation. However, it was not supposed at the outset that our investigation would add anything new to science, the prime object being to learn how to practice some of the scientific and theoretical principles of agriculture, so thoroughly taught in the university, since theory unless connected with experience, often results in failure, in solving the practical problems of business life.

Aside from the opportunity of experimentation, it was our privilege to accompany Mr. Warner on his trips about the farms, and to assist in the annual farm inspection. This gave an ex-

cellent opportunity to observe and compare the methods and practices of the 127 tenants on the Sibley estate, and many practical points were gathered.

The Illinois College of Agriculture has taken the initiative in this plan which thus far has proved satisfactory, and it is hoped that the practice will be continued.

VARIETIES OF OATS.

By H. D. Scudder, Class of 1902.

The experiments with varieties of oats, carried on at the University farm during the past summer, are a continuation of the tests of the previous year with about twice as many varieties as were used at that time. The object of the experiment is the comparison of the different varieties of oats, grown under ordinary farm conditions of soil, cultivation, etc., as to the following points—yield per acre, weight per bushel, straw per acre, time of ripening, percent of smut.

The field on which the oats were raised, is about twenty-five by fifteen rods, lying north and south. It is level, and of a black loam soil. The land was in corn the previous year, and was left in good condition for the oat crop. The area was divided into plats one by two rods, with a sufficient intervening space between the plats to prevent mixture of varieties in seeding.

The seed used, was obtained, partly from prominent seedsmen of the country and partly from crops raised on the University experiment farm. In all cases the seed was a selected sample of its variety. On the 6th of April, all of the varieties were sown, using two quarts to the plat. The ground was then disced twice and harrowed twice, with a spading disc and a

smoothing harrow. Each variety was repeated on three different plats in different parts of the field, so that all conditions that the field contained, were undergone. The results in all cases are averages of these three repetitions.

The different varieties were harvested by hand as they ripened (the yellow ripe stage), there being a wide difference as to time of ripening in the several varieties. The dates of harvesting were from July 8th to 21st.

A heavy wind and rainstorm in the first of the month of July, laid the larger part of the field of oats, flat on the ground, the field being fully exposed to the violence of the wind. The hardier varieties remained standing or regained their upright positions, but a large minority, the less hardy varieties, remained lodged. Following is a list of those varieties damaged by the storm.

Badly lodged—Silver Mine (Olds)—Bartley's oats—New Alaska—Power's oats—Lincoln (I. S. Co.)—Percivil oats—Calgary Grey (U. of I.)—Clydesdale (U. of I.)—Russian (U. of I.)—Lincoln (Stokes)—Early Champion—Irish Victor—Sibley White—Clydesdale (Stokes)

About 30% lodged—Beagley's Illinois—Sibley Black—Michigan Wonder (U. of I.)—Silver Mine (U. of I.)—White Bonanza (U. of I.)—White Main (U. of I.)—Great American.

The varieties not named above were uninjured, not lodged. The results of the experiment as to comparison of yields, etc., are as follows:

Name of Variety.	Source of Seed.	Bushels per acre.	Weight per bushel.	Straw per acre in lbs.	Time of Ripening.	Per cent. Smut.
Red Rust Proof	University of Illinois	55.4	35.5	3653	Late.	1
White Bonanza	University of Illinois	55.1	32.9	4173	Medinm.	5
Lincoln	L. L. Olds, Clinton, Wis	54.7	33.2	3926	Medium.	10
Fursman Oats	E. S. Fursman	53.7	32.8	4346	Medium.	8
Power's	University of Illinois	53.1	32.6	4193	Medium.	3
Silver Mine	L. L. Olds, Clinton, Wis	52.9	31.9	4313	Medium.	9
Lincoln	Iowa Seed Co., Des Moines, Iowa	51.8	33.	4180	Medium.	4½
Imperial White Russian	University of Illinois	51.6	32.5	4260	Late.	5
New Zealand	University of Illinois	49.7	32.5	4406	Late.	3
Iowa Prolific	University of Illinois	49.3	33.1	4020	Late.	6
Iowa White	J. H. Beagley, Sibley, Ill	48.7	31.6	4680	Late.	6
Russian	University of Illinois	48.4	36.3	4510	Medium.	2¼
Lincoln	Johnson & Stokes, Philadelphia, Pa	48.	31.8	4193	Late.	9
Irish Victor	Iowa Seed Co., Des Moines, Iowa	47.4	30.3	3933	Medium.	4
White Main	University of Illinois	47.2	32.6	4153	Very late.	1
Salzer's Big Four	L. L. Olds, Clinton, Wis	46.8	34.	4140	Medium.	10½
Black Tartarian	University of Illinois	46.2	34.	3520	Very early	16
Calgary Gray	University of Illinois	46.2	33.4	4066	Early.	9
Beagley's Illinois	University of Illinois	45.8	32.1	3813	Late.	5
Great American	Everett	45.6	33.5	4166	Medium.	21
Danish	Johnson & Stokes, Philadelphia, Pa	45.4	33.3	3293	Late.	22
Fourth of July	Everett	45.	31.3	3800	Very late.	1
New Welcome	Johnson & Stokes, Philadelphia, Pa	44.9	33.7	3573	Late.	9
White Main	Johnson & Stokes, Philadelphia, Pa	44.5	31.7	4053	Medium.	13
Texas Rust Proof	University of Illinois	44.5	33.5	3893	Early.	7½
Michigan Wonder	L. L. Olds, Clinton, Wis	44.3	31.	4826	Late.	10
New Zealand	Iowa Seed Co., Des Moines, Iowa	44.3	32.8	4353	Very late.	1½
Clydesdale	Johnson & Stokes, Philadelphia, Pa	44.1	31.5	4586	Very late.	9
Lincoln	University of Illinois	44.1	32.7	4093	Late.	3½
Michigan Wonder, No. 1	University of Illinois	43.1	33.2	3820	Very late.	6
Michigan Wonder, No. 2	University of Illinois	42.9	31.2	4570	Medium.	5
Washington	University of Illinois	42.	34.5	4186	Late.	5½
White Superior Scotch	Everett	42.	33.3	4343	Early.	10
Sibley White	J. H. Beagley, Sibley, Ill	42.	32.2	3800	Late.	10
Silver Mine	University of Illinois	40.9	33.8	4010	Late.	7½
Bartley	University of Illinois	40.7	33.7	4193	Medium.	16
Clydesdale	University of Illinois	39.3	33.	4320	Late.	2
Sibley Black	J. H. Beagley, Sibley, Ill	34.9	34.8	3680	Late.	7½
New Alaska	Barnard	33.5	35.	3400	Very early	14
Early Champion	Iowa Seed Co., Des Moines, Iowa	30.2	35.	3366	Very early	14
Percivil	University of Illinois	30.1	33.5	3373	Early.	12
Alaska	University of Illinois	23.6	32.2	3773	Early.	21

THE TEACHING OF AGRICULTURE IN THE RURAL SCHOOLS.

By J. E. Readhimer, Class of 1903.

There is a wide spread feeling among the rural population that farming is not only an unprofitable occupation but that it is a degraded one. Acting upon these delusions, many of the best people are leaving the rural districts and congregating in the cities. This migration to the cities is strengthened by the fact that cheap farming lands are becoming scarce. Only the fortuate few can hope to own farms at the present values of lands and with the present methods of cultivation.

When lands were plentiful and could be had for the improving, and the farmer gave no thought to the "keeping up" of the fertility, the necessity for agricultural education was not so keenly felt. But with the scarcity and high price of land, and the low price of farm products, has come the necessity for improved methods in agriculture.

Much has been done in recent years along this line, both by the general government and the individual states. Many colleges and experiment stations have been founded for the purpose of conducting experiments in the best methods of tilling and improving the soil. More can be produced now than ever before with the least amount of labor.

The farmers in general are awakening to their interests. Farmer's Institutes are being organized in nearly all the counties. State and county fairs are held annually where questions affecting the welfare of the farmer can be discussed, and where exhibits of farm produce can be made. All of these means have a place and are accomplishing a great good, but the great mass of farmers is not reached by them. What is needed most is to educate the boy—to teach him that farming is not only an honorable but that it is one of the noblest of callings. To do this,

he must be trained while young, before he has become prejudiced against the farm.

Attempts to introduce agriculture into the rural schools have been made from time to time during the past century, but each effort proved a failure largely because too much was undertaken. The science of agriculture is too difficult for the average common school pupil, and a subject of which the ordinary teacher has very little knowledge. There is, however, a work that is directly related to agriculture that can be successfully carried on in the most elementary schools. I speak of nature study work.

The state of New York, a short while ago, appropriated $25,000 to be used in introducing nature teaching in the common schools and the conducting of simple agricultural experiments in different parts of the state under the supervision of the College of Agriculture of Cornell University. Much satisfactory progress has been made in this movement. Missouri has recently passed a law requiring instruction in agriculture and horticulture in the rural schools.

There is no reason why nature teaching as proposed by Cornell University should not prove a success and be of great value to the children of the State of Illinois. There is nothing that trains the powers of observation as does the natural objects, and this is the element most lacking in the common schools and the one most useful to the farmer. Most children see very little of the things around them. They do not see or understand the beauties of nature around them—the trees and flowers, birds and insects are all strangers to them. The teacher who can interest the child in these things and fix them in his mind is doing him an inestimable service. No one can attain scientific facts who does not know how to observe closely and accurately. The scientist differs chiefly from his fellow men in that he sees better than they. The power to see things is not only a great pleasure, but it is of much practical value. Many farmers have seen the need of this faculty and have acquired it by their own efforts. These are the ones who most regret not having had the help of a trained teacher in early life. The country is the best place for nature teaching, and the country boy needs it most. It would be of great help to him in after-life and would do much toward

instilling in him a love for country life that would cause him to scorn the idea of leaving the farm for the crowded streets of the city.

The agricultural college of Cornell University issues leaflets bearing on subjects related to agriculture.

These leaflets are used by many teachers as a basis for their nature-study work. The leaflets take up such subjects as the planting of seeds and the subsequent study of the young plant at different stages of its growth; the study of insects that injure fruit or grain; the making of collections of insects about the homes, and watching to see whether they are beneficial or injurious to the farmer; the study of weeds injurious to the farmer and methods of eradicating them; the planting of seeds at different depths and the results; the germination of seeds; good and bad seeds and how to test them are only a few of the many valuable lessons that might be learned in the most elementary school.

It is encouraging to know that our own University has taken up the work of agriculture in the common schools. An outline of work for each month has been developed by the College of Agriculture and published in the State Course of Study for 1900. The subjects are divided into crop series, horticulture series, and animal series. The work consists in observations and experiments to be made by the individual pupils under the guidance of the teacher. The subject-matter is simple in nature, but is calculated to develop in the child a power for careful and accurate observation of things around him. Teachers and pupils soon become deeply interested in the work and many schools are making a gratifying success of it.

The schools of Champaign County have undertaken the work under the direction of Superintendent Shawhan, and report highly satisfactory results. What is being done by the teachers of Champaign County can be done by the teachers of every other county.

This is the kind of teaching that the child-mind craves. With it the school is not the dreary place that too many schools often are, but a place of life and sunshine. The boy who is thus taught will come to see a new value and dignity to farm-life,

and the boy who is thus taught to observe accurately the workings of nature in her influence on farm production, and who becomes acquainted with the foes with which agriculture has to contend, has vastly increased chances of getting more from his contact with the soil than his less fortunate brother.

THE FARMER'S GARDEN.

By Robert B. Endicott, Class of 1903.

The garden of today is not simply a small patch on which are grown a few vegetables for table use in early summer, but it is a place large enough to grow an abundant supply of all kinds of vegetables, fruits, and flowers. Its position will be governed to some extent by the location of the buildings on the farm, and by the nature of the soil; but it should be placed as near the house as possible, and convenient to the kitchen. If a rich, mellow, well-drained, slightly sandy piece of land, with a southern or eastern exposure, can be secured near the house, it will make an ideal garden spot.

The size of the garden will depend upon the kind of farming practiced. On a fruit farm, for instance, there would be little need of fruit trees in it, but on a grain or stock farm, where the fruit supply is limited to that grown in the garden, it is best to make it sufficiently large to provide an abundant supply, especially of the small fruits. For convenience in plowing and cultivating the plat should be long and narrow rather than square, with the rows running lengthwise. A garden four times as long as it is wide is of convenient shape to work with a horse.

The preparation of the land should be thorough. If it is not

already very rich, it should be made so by the liberal use of well-rotted stable manure. Thirty or forty loads per acre is not too heavy an application. It should be evenly distributed over the ground in late winter, and as soon as the ground is dry enough to plow in the spring, turned under six or seven inches deep. It is not a good practice to put strong manure where fruit trees and vines are to be set, but coarse material may be used to loosen up the soil and add humus. If the ground is plowed when it is just dry enough to crumble without sticking to the hand it may easily be reduced to a fine condition by harrowing two or three times and planking, if the surface is not allowed to become dry. No seeds should be planted until the soil is thoroughly pulverized. When this has been done, they should be put in at once, as they will germinate better in freshly worked soil than in soil that has been allowed to dry out, or has been packed by rains.

In the choice of the seeds for planting, consideration should be given to the matter of securing a succession of the same vegetable for a longer period than one planting of one variety will provide. This is especially true of the earlier vegetables, such as lettuce, peas, and beans. It may be secured either by planting varieties of different degrees of earliness, or by making successive plantings of the same variety. The list of vegetables should be such as will give a continuous supply throughout the season, and at the same time give a variety. It should include, beside the early vegetables, beans, sweet corn, tomatoes, and a liberal supply of melons and squashes. On account of striped beetles, squash bugs and boys these last may be hard to raise, but to the successful grower they furnish a very welcome addition to the bill of fare.

It will be found convenient to plant the vegetables maturing about the same time together, in order to allow the ground to be made use of when they are gone. Small crops such as bunch onions, head lettuce, etc., which require similar care, may be planted in the same row; and if the rows are placed far enough apart, much labor may be saved in cultivating, by the use of a narrow-toothed cultivator or wheel hoe. As soon as the plants are up so that the rows can be seen, cultivation should begin. The garden is generally a weedy place, but it need not be if

it is looked after in time, and the weeds not permitted to get a start. By the use of a horse-cultivatior no great amount of time is required to keep it reasonably clean, but it should not be made a rainy day job. The surface should be stirred as soon as it is dry enough after each heavy rain, and at other times, enough to keep the weeds in check and the top soil loose.

When the early crops have passed their period of usefulness they should be cleared away, and the ground broken up at once to be planted in some late crop, such as late cabbage, celery, or turnips. By so doing the supply of vegetables may be kept up almost without a break throughout the season. At the same time the ground remains covered, and the late crop of weeds is kept down. This is no small consideration in a garden, the location of which is permanent, as the weeds are a large item in any case, and where the late crop is permitted to grow and seed, they become almost unmanageable. In case the ground cannot be occupied by vegetables it may be well to sow some cover crop, like rye, which can be plowed under early in the spring. This will prevent washing and leaching of the soil, and add humus.

A good garden on the farm requires some sacrifice in time and labor, often at a season when it can ill be spared, but the gain in quality and variety in the bill of fare is such as to warrant the sacrifice. It means also no small saving in the living expenses. And when to these may be added an interest in the garden itself, and a pride in its perfection, it comes to be a factor in farm life which no intelligent farmer should be without.

SPRAYING.

By A. W. Bryant, Class of 1903.

Spraying is the art and science of applying liquids or semi-liquids of a caustic, poisonous, or offensive nature, to the branches, foliage or immature fruit of a tree, shrub, vine or plant, to prevent the invasion of fungous diseases and to check or prevent the ravages of insect pests.

As early as the middle of the eighteenth century, we read of the application of various substances to trees and plants, for numerous mildews, insects, etc. However, no system was followed, and generally the first thing handy was taken, the substances being characterized by their offensive and disagreeable qualities.

The merits of copper sulfate the active ingredient of the standard fungicide of today, the Bordeaux mixture, were discovered incidently in France in the early eighties of the nineteenth century. About this time the downy mildew of the grape, coming from America, had made its appearance in the vineyards surrounding the city of Bordeaux and was playing havoc with them. Many of these vineyards were bounded by highways, and the owners suffered considerable loss from the stealing of grapes by children and travelers, and consequently had gotten into the habit of coating the vines and fruit near the road, with a wash made of lime and some salt of copper, usually the sulfate it being the cheapest, in order to give the fruit a poisoned appearance, It was noticed, when the mildew struck the locality that vines so treated held their foliage and were healthier in every way, and this started experimenters to work and the result is the Bordeaux mixture of today. The development has been decided, tho necessarily slow and must be credited to the Erench altho the perfection was perhaps brought about by the Americans.

In America about 1860, the currant-worm in the east and the Colorado potato beetle in the west began to make great ravages. The potato beetle was a native of Colorado, feeding upon wild native plants, but at the introduction of the potato, took to that and made things look dreary for the farmer. In fifteen years it had traveled two-thirds across the continent to the Atlantic seaboard leaving ruined potato field in its path. The farmers were exceedingly discouraged. They argued that if they could not control a soft-bodied larva like the currant-worm what could they expect to do with an insect having a hard horny coat like the potato beetle. But "necessity is the mother of invention" and Paris green was soon discovered to be of great value in controlling these pests as well as all other chewing insects. It was when applying it to trees for the canker-worm, that it was found to greatly lessen the number of Codling moth.

Thus today we have three standard spraying solutions, namely: the Bordeaux mixture, a fungicide; Paris green and water, and the kerosene and soap solutions, both insecticides. The making of these solutions is an important process and we will take them up one by one. The easiest and most practical way to make the Bordeaux mixture is as follows: Having figured approximately how much solution you are going to need, for one spraying, (this may be largely guess work the first time) weigh out 4 lbs of copper sulfate for every 50 gallons you will need. Suppose you need 500 gallons of solution, then weigh out 40 lbs of copper sulfate and measure out 40 gallons of water into an open barrel. Suspend the copper sulfate in this water, by means of a coarse sack, as near the surface as possible, keeping it entirely immersed. Weigh out 4 lbs of fresh quick lime for every 50 gallons of solution, in this case 40 lbs. Carefully slack this in a barrel, measuring all water used and finally diluting to 40 gallons. To properly slack the lime, requires more knowledge then most people think. Add but a little water at first until it begins to warm up, and then add more water slowly, but fast enough, however, to prevent burning. Stir up from the bottom often, otherwise the lime may burn altho it is covered with water.

We now have what we term stock solutions. The solution

as applied to the trees should contain 4 lbs of copper sulfate and 4 lbs of lime for every 50 gallons of water. If your spraying tank holds 50 gallons, fill it nearly full of water and then add 4 gallons (4 lbs) of the stock solution of copper sulfate and 4 gallons (4 lbs) of the stock solution of lime after having stirred both thoroughly. Strain everything that goes into the tank even the clear water, thereby keeping out all coarse material that would clog the pump. Finish filling the tank and the Bordeaux mixture is ready to apply.

Paris green, one of the insecticides, is prepared for use by mixing with water at the rate of one pound to 200 gallons of water. I say mixing because it does not dissolve, therefore, care must be taken to have it thoroly mixed. One way of doing this is to weigh out the amount needed, put it in a jug, partially fill with water, cork up, and thoroly shake, then pour the contents into the spraying tank and rinse out the jug. It is well to add a little lime, say one pound to 50 gallons of water to guard against burning the foliage. Remember that lime has no properties as an insecticide or fungicide worth mentioning, but is added to counteract the caustic action of the copper sulfate on the foliage.

It has been found out that Paris green can be added to the Bordeaux mixture in the same porportion as to clear water and that its insecticidal value will not be impaired, neither will the fungicidal value of the Bordeaux mixture be affected. Thus we have a combined fungicide and insecticide which may be applied at one spraying.

Paris green is of value, only with the chewing insects, such as the canker worm, currant worm, codling moth, etc., and for the aphis and other sucking insects we used solutions that kill by contact such as the Kerosene Emulsion or Whale oil soap. Kerosene Emulsion is made as follows: Dissolve ½ a pound of hard soap in one gallon of hot water and to this add two gallons of kerosene. Thoroly emulsify until it is of a creamy consistency and appearance and then dilute with from 15 to 50 gallons of water according to the character of the pest you are combating.

Whale oil soap is used in the proportion of one pound to ten

gallons of water. Dissolve the soap in a small quanity of hot water and then dilute to the desired porportion. This mixture is largely used against the scale insects. Kerosene and water mechanically mixed by special pumps is being used to some extent with varying success.

Now just a word about the machinery. Get the very best equipment and one of sufficient size. Consult a man who has had experience, rather than the pump man. The essential points of a good pump are, that all working parts be of brass, that the necessary valves are simple and that it has no stuffing or packing boxes. Have a sufficient length of hose, (15 to 20 feet) and a bamboo pole, 8 to 12 feet long for spraying the larger trees. Use a nozzle of the Vermorel type, one that throws a finely divided dense spray. Keep a small box on the wagon and in it a hammer, a suitable wrench, a screw-driver, a pair of pliers, a piece of small copper wire, a piece of thin leather, some hose couplers and gaskets, a few nails and a screw or two, and they will often save considerable time and a good deal of hard language.

To spray thoroly, three applications are necessary, each time using the Bordeaux mixture with Paris Green added, but the third time using only two pounds of copper sulfate and two pounds of lime to 50 gallons of water. Spray first just as the flower buds are bursting; second, just after the petals have fallen; and third, a week to ten days later.

For canker worm, apply Paris Green as soon as the early ones make their appearence and for aphis or the scale insects apply Kerosene Emulsion or Whale oil soap, and in case it is the latter pest notify the State Entomologist.

Spraying to be successful must be done thoroly, year after year, and then its benefits will be far-reaching. If you are an orchardist or fruit-grower, even on a small scale, study the subject of spraying and learn to do it intelligently. But do not stop the good work at spraying, study, cultivate and care for your orchard and it will be next thing to a veritable gold mine.

POLLINATION AMONG FRUITS.

By D. F. Berger, * Class of 1902.

All observant fruit-growers have seen trees which blossom full, but set little or no fruit. Such trees may be large and vigorous and we wonder why they are barren. This is perhaps most often seen in the case of single trees which stand at some distance from others of the same species, and this fact gives a clue to the explanation. Almost everyone has observed that the ear of an isolated stalk of corn bears only a few scattered kernels. This is because the pollen of that stalk is incapable of fertilizing the ovules of that ear. The difficulty is not in a lack of pollen, as this may be shed so abundantly as to cover the blades of the stalk, giving them a yellowish tint, and still the ear be practically barren. But let several stalks be grown near together as in a corn field, where each ear may receive pollen from other stalks, and all the ears bear corn. That is, the pollen from one stalk may be able to fertilize the ear on another stalk, when it is not able to fertilize the ear on its own stalk, in which case we have self-sterility. In the same way a tree may be self-sterile. In fact a great many fruit-trees are more or less self-sterile, and this is why an isolated tree is not likely to bear.

In the case of orchards which blossom full but do not bear, the same cause may be operating. Such orchards very frequently consist entirely of one variety, or of large blocks of one variety planted together so that they are isolated from the others. Now it is an established fact that pollen from another tree of the same grafted variety is little if any more fertile, when applied to the pistils, than pollen from the same tree. This is probably because all the trees of such a variety are grown from wood of one original tree, so that they are in reality only parts of one and the same tree. In an orchard of one variety we have,

* Died, January 31, 1901.

then, our old problem of an isolated tree, only on an enlarged scale; so that if a single tree of a variety proves to be self-sterile, an orchard made up exclusively of that variety is likely to be unfruitful.

Not all varieties of orchard fruits are self-sterile, however, and a variety which is self-sterile in one locality may be partially self-fertile in another. This can be determined only by trial. But even with varieties that are self-fertile, better results have been obtained in the quantity and quality of the fruit where cross-pollination have been practiced. It is important then, in setting out an orchard, that proper attention be given to this matter. It is not necessary that a great number of varieties be selected. Two or three standard sorts are sufficient if rightly chosen and properly planted in the orchard. The problem in this case is similar to that in the case of strawberries. No experienced strawberry grower would set out a patch of pistillate strawberries unless he planted along with them some staminate variety that was known to be a good pollinizer.

In choosing varieties with reference to pollination care should be taken, first that the varieties chosen will bloom at the same time, or at least that their blooming periods will overlap; and, second, that they will actually be interfertile. That the first is necessary is self-evident, for if the varieties do not bloom together cross-pollination cannot take place. Among pears the Oriental varieties, as Kieffer, usually do not bloom with the European varieties, as Bartlett; and the three classes of commercial plums—Japanese, domestica, and native usually bloom at different periods, in the order named. But the comparative blooming of varieties is to a certain extent a local problem, subject to the conditions of soil and climate, and to the weather during the blooming season, so that varieties which are well adapted for cross-pollination in one locality may not be in another.

But not all varieties of a fruit that bloom together may be used for cross-pollination, as some are not inter-fertile. This is especially true among plums. It has been found for example that the Whitaker will not fertilize the Wild Goose, nor will Early Red fertilize Caddo Chief. Such combinations should of

course be avoided wherever possible. Among other fruits as well as plums it seems that certain crosses give a better quality of fruit than other equally fertile crosses, but this point needs further investigation before it can safely be used to any extent in practice.

The varieties used as pollinizers need not be worthless sorts. Suppose for instance that it is desired to grow a certain variety of apples for market. Now whether it is self-fertile or not, better fruit can usually be obtained by cross-pollination. Hence the first step will be to find out the blooming season of this variety—whether early, medium, or late. Then it should be determined, as far as possible, which of the desirable varieties blooming at the same time have given satisfaction as pollinizers for that variety, or at least which, if any, have proven unsatisfactory. A list might thus be obtained from which one could choose with safety. At present there seems to be no way of determining the blooming season of varieties, or which varieties are not inter-fertile, except by observation and inquiry.

After the varieties have been selected it is essential that they be properly distributed throughout the orchard. The number of trees of each will depend largely upon its market value. Theoretically it would be best to mix the varieties in each row, as they would then be more evenly distributed, but practically it is better to plant them in seperate rows. Some growers plant every tenth row to the pollinizer, but the proportion should usually be greater. It is recommended to have not more than three or four rows of variety together.

The pollen is distributed mostly by the bees. It is generally considered that the wind plays an important part in the distribution of pollen, but the writer is inclined to think that such is not the case. The results obtained by experiments with wind-pollination have have not been satisfactory, and Prof. Waugh, of Vermont, even goes so far as to say that "It seems fair to conclude - - - that insects are necessary to pollination; and if the wind is ever of any use in this work, it plays a very subordinate part."

BEES AND AGRICULTURE.

By Edmund L. Worthen, Class of 1903.

There being a large crop of fruit in the west last year and a very poor flow of honey, it is not surprising that there arose an ill-feeling between the fruit-growers and apiculturists, although it has been pretty well proven that bees do not injure sound fruit. One of the best proofs of this statement is found by microscopic examination of the jaws of the honey-bee. Their mandibles are smooth, the bee is unable to puncture the skins of any of our fruits; but the wasps and hornets with their saw-like mandibles, can, with little difficulty scrape a hole in many of our fruits. Aristotle some two thousand years ago stated that "Bees do not injure sound fruit." A strong argument in favor of this statement is, that there are thousands of our principal fruit growers who are bee keepers, and further the intelligent fruit growers are becoming satisfied that they cannot get the best results from their orchards or vineyards unless they or some of their neighbors keep bees.

Thomas Newman says in his book, on "Bees and Honey," that, "Bees do not puncture fruit, as some assert. When fruit is over ripe, or the skins of grapes are bursted, the bees will sometimes, when no honey can be gathered, appropriate the juice greatly to their detriment. Such juices soon sour in the hives, and become unfit for the food of bees in winter, and disease and death is the result. Many bee keepers also raise fruit. and their testimony universally agrees with the statement made here."

During the summer of 1879 Chas. Dadant, of Hamilton, Ill., carried on some very interesting experiments along this line. He says, in the revised edition of Langstrott on the "Honey-bee," "The summer of 1879 being exceedingly dry, the grape crop was

large and the honey crop was small. In every vineyard a number of ripe grapes were eaten by bees, and the grape-growers in our vicinity were so positively certain that the bees were guilty, that they held a meeting, to petition the state legislature, for a law preventing any one from owning more than ten hives of bees." It would have been a very serious drawback, not only to the bee keepers but also to the horticulturists if such a law had been made. It was during the fall of this year that Mr. Dadant made the following experiment—as he was hauling his grapes from the vineyard the bees litterly swarmed around the barrels in which the grapes were hauled. He says, "Removing the barrels I left one bunch of sound grapes, on the wagon, puncturing one of the grapes with a pin. This bunch being the only one remaining exposed, was at once covered with such a swarm of bees that it was entirely hidden from sight. This was at three o'clock in the afternoon. At sunset the bees were all gone, except three, which were to exhausted to fly. The bunch had lost its bloom, the grapes were shiny, but entirely sound. The one punctured grape had a slight depression at the pin hole, showing that the bees had sucked all the juice they could reach, but they had not even enlarged the hole."

In the fall of '98 I placed a bunch of sound grapes in a strong hive of bees, directly under the oil cloth which covers the frames, thus the grapes were in free access to the bees. In about two weeks I examined this hive and found that the grapes were of a shiny appearance, being caused by the bees running over them, they were also glued to the frames and oil cloth with propolis but otherwise the same as when put in. There was not a single grape of the bunch that was punctured.

Mr. McLain of the United States Apicultural station thoroughly tested this subject. The report of his tests may be found in the Agriculture Report of 1885. His results were the same as most others, that the honey bee cannot puncture sound fruit and consequently cannot injure it.

There is much damage done to grapes by birds. The oriole in our vicinity being by far the worst, but the thrushes if in large numbers are also very destructive. These birds thrust their bills into the grapes and suck a small amount of juice from each

one. A single bird in this manner destroys several pounds of grapes in a day, as those that are punctured soon dry up and are worthless. These punctured grapes with their sweet juices exposed, are a great temptation to the bees. Thus in the summers and falls when the honey flow is light, the bees gather a large amount of this juice and store it in their hives. As before stated these juices are unfit for winter food and often cause disease and death of the bees. In seasons when there is a good flow of honey during the summer and fall, the bees do not bother the fruits but gather honey from other sources. Many fruit growers become jealous of the apiarist believing that he is making a profit out of the juices that his bees gather from their fruit. This is a great mistake, for all apiarists know how much better off their bees would be if they never gather a drop of fruit juice.

Bees often, in dry seasons become troublesome around watering troughs where they often sting the stock. This trouble would be lessened if not entirely stopped by the apiarist if he would provide some convenient means in his apiary by which the bees could get water at any time. If this is done the bee will soon become accustom to getting there supply of this liquid at home.

As pollen adheres to the body of bees while on the blossoms in search of food, and is transfered from flower to flower, they aid greatly in the pollination and cross-fertilization of plants. How often have we noticed that there is very little fruit set when the weather is cold and damp during the blossoming season and the bees are forced to stay in the hives. This fact is also quite noticable to the strawberry growers. I remember a few years ago when our fine patch of Greenville berries was a complete failure, there being only a few berries and these of a very small size. During the blossoming period we had almost continuous rain and cold so the bees were confined to their hives and were unable to assist in the pollination of the blossoms.

It is quite well known that fruits are better, when fertilized by pollen from a different blossom than their own. In some varieties of pears fertilization would be impossible, without the help of insects; as their pollen is sterile, while other varieties of the same fruit are capable of self-fertilization.

Experiments have proven that crosses in apples enlarge the fruit, cause it to be more highly colored and better supplied with larger seeds. In some blossoms such as those of the willow-herb the stamens mature and shed their pollen before the pistil is ready to receive it, thus it would not become fertilized unless the pollen from some later blossom be carried to it. In the case of the Simpson-honey-plant the female organs are receptive before the pollen is ready. In other plants, such as the willow the male organs are on one plant and the female organs on another, in this case the pollen is often carried from the male blossom to the female one by bees visiting one for pollen, and the other for honey.

The apple has five carpels, each requiring a distinct pollenization. If one of the carpels is not fertilized there will be an abortive seed, and the side of the fruit nearest this point will also be correspondingly undeveloped.

It is a well known fact among farmers that the first crop of red clover furnishes little seed compared with the second one. This is due to the fact that the bumble-bees are very scarce in the spring as only the queen lives over winter. They are much more plentiful in the summer, so we see that the bumble-bee is of great service in fertilizing red clover. In a few years we will, in all probability, have a strain of honey bees that will work on red clover, as there are at present a number of our prominent apiculturists breeding bees, for the purpose of lengthening their tongues so they may be able to gather honey from the deep corolla-tubes of the red clover and I may say that they have attained great success for the remarkably short time they have been at work. There are also others who are succeeding in breeding red clover with shorter corolla-tubes. A strain of bees that would work on the red clover would not only benefit the farmer, by fertilizing his crop, but also they would greatly help their owner by gathering for him thousand of pounds of honey that are now going to waste.

There are many farmers who today have a great prejudice against bees, but the best informed, consider them their friends. Why should this prejudice still exist in so many instances? Are not the interests of farmer and apiarist mutual? Is not one

benefited by the other? Certainly, without one the other would deteriorate. Then why not be friends? The farmer should not think that the bees are robbing him, but on the other hand should keep constantly in mind that they are of great value to him.

SILAGE AND HIGHLY NITROGENOUS FEED IN RATIONS WITH CORN FOR STEERS.

By L. S. Robertson, B. S. 1900 and E. T. Robbins, B. S. 1900.

The breeder and feeder of cattle for the block is confronted, not so much with the problem of producing the greatest excellence of condition in the animal, as with the more difficult one of so planning his feeding as to market his grains and forage to the best advantage when turned into meat. In doing this he must use most extensively the feeds which furnish the cheapest nutriment, but it is not safe to rest contented with the application of that criterion alone. The Illinois farmer has cheap corn and an abundance of hay. The corn is usually husked and the grain fed, the stalks being left on the ground and wasted except for a little pasturing of them. With this method about one third of the feeding value of the corn plant is wasted, while a more expensive rough forage is fed in its stead.

Even when the corn is cut, shocked and cured in the field the loss is very great, about 25% of its nutriment in curing, 40% of the remainder in refuse stalks and a variable and often large amount wasted by trampling underfoot when fed by scattering on the ground. Thus 50 to 60% of the stover is lost even when it is handled by the most careful methods. Again, among farmers corn alone is generally considered the best feed for fattening animals, if not for producing the largest gains for a given weight of feed, at least for producing the cheapest gains. Experimental evidence does not support this view.

In order to determine the method by which the corn crop can be used most fully and most economically for feeding cattle, an experiment with steers was conducted at the University of Illinois in 1899—1900. The investigation followed two lines: (1) As to the best utilization of the stalk of the corn plant, (2) as to the effect of increasing the nitrogen of the ration consisting otherwise entirely of corn.

The 9 steers used in the experiment were high grade Shorthorns, 30 months old at the beginning of the experiment, and were selected from a bunch of 40 all sired by one bull and raised in one herd. The attempt was made to get them uniform. They were divided as evenly as possible into 3 lots of 3 steers each. The steers were confined at night in stanchions in a stable having a compartment for each lot, and each lot had the freedom of an adjoining yard during the day. A bunch of 3 pigs followed each lot of steers.

Each steer had a separate manger and was provided with a burlap apron one end of which was tied around his neck and the other tacked to the edge of the manger so that none of the feed could be wasted. Weights were taken of every thing given each steer and of every thing he refused to eat. The steers were weighed every 4 weeks on three successive days at 10 to 12 a. m., before watering, and the average of the 3 weights was taken as the correct weight for the middle day. Feeding was done at 5 a. m. and at 3 p. m. Monthly moisture determinations of feed and refuse formed the basis for a fairly accurate reduction of refuse materal to the same moisture content as the feed. Thus a frequent source of error in the deduced weights of feed actually eaten was obviated. These moisture determinations also served as the basis for calculations comparing the results from silage and from fodder.

Corn was made the basis of the feeding since the utilization of the corn crop is the great problem, of the Illinois steer feeder. Stover (husked fodder) was used for dry forage and to facilitate the weighing of it, it was shredded. The steers were not compelled to eat the stalks. These almost solely constituted the stover refuse.

The steers were fed as follows:—Lot 1, Stover, ear corn,

gluten meal. Lot 2, Stover, ear corn, corn silage. Lot 3, Stover, ear corn.

With lot 1 it was deemed advisable to have the very concentrated feed—gluten meal—diluted with some lighter material so part of its ear corn, was ground whole and mixed with the gluten meal, 1 part corn and cob meal to 2 parts gluten meal. Gluten meal was used to add protein to the ration because it was then the cheapest source of protein on the market. The gluten meal contained 38% crude protein and it was estimated that it furnished 30% digestible protein. It was fed in such proportions as to make the nutritive ratio about 1:7.5. In order to furnish a basis for a accurate comparison between silage and whole corn fodder lot 3 was given in place of the silage of lot 2 an addition of corn and stover in the proportion in which they were yielded by the corn plant, in this case 56 parts ear corn to 44 stover. Lot 1 was given this whole fodder and the same additional stover given lot 3 and besides was fed corn and gluten meal. Thus the whole fodder and stover of lots 1 and 3 were the same for the two lots and comparison was obtained between the corn and gluten meal, of lot 1, and the corn of lot 3; the stover and ear corn were the same for lots 2 and 3 and comparison was obtained between silage of lot 2 and whole fodder of lot 3. The varying appetites of the steers were satisfied as far as possible by variations in the amount of those feeds between which comparison were made.

The silage used Dec. 14 to Feb. 9 was of poor quality and probably accounts in part, for the fact that at no time would the steers take a very large amount. The silage fed after Feb. 9 was good but the steers seemed by that time to have established the habit of eating sparingly of it. The steers had never previously received much grain feed and so did not become accustomed to heavy grain feed quickly. The amount of grain was increased slowly until on Feb. 1 after 6 weeks feeding the steers were getting about all they cared for varying with different steers at about 15 lbs ear corn per day. They gradually increased the amount taken, however, until at the end of the experiment May 30 the heaviest feeders took 28 lbs per day.

Table I. gives a summary of the feeds eaten and refused by

each steer in periods of 4 weeks throughout the experiment, from Dec. 14 to May 30. The weights given for refuse stover are the weights of the refuse at the same moisture content as the stover fed. Altho corn was fed in the ear the amount of shelled corn, as calculated from several tests, is given in one column in the table and the cobs are recorded separately.

It will be noticed that lot 2 was fed silage during the first 4 periods only. At the end of that time the supply of silage was exhausted so the lot was changed gradually to whole fodder the same as lot 3. Steer 28 was badly upset by the change and never afterward ate well, was easily thrown off feed, and made to scour, and of course he made poor gains. Aside from this instance there was nothing very irregular in the behavior of any of the steers. Of course as the tables show some steers were better feeders than others, but the good and poor steers seemed to have been quite evenly divided between the lots.

Comparing lots 1 and 3 we find that the totals of stover and grain eaten were nearly the same, being slightly larger for lot 3, but lot 1 made a total gain of 951 lbs against 712 lbs gain, by lot 3. In place of 1576.7 lbs of the corn consumed by lot 3 lot 1 ate 1502.8 lbs gluten meal and as a result gained 239 lbs or 33.6% more than lot 3. The poorest gainer of lot 1 made practically the same gain as the best of lot 3.

Table II. gives the data in such form that the work of lots 2 and 3 can be better compared for the 4 periods during which silage was fed. The two lots ate the same total amount of corn and practically the same amount of stover, while lot 2 ate 6385.7 pounds silage in place of 3269 pounds fodder eaten by lot 3. The total dry matter, eaten in silage was only 2088.55 pounds against 2678.9 pounds dry matter eaten in fodder by lot 3. In the gains however lot 2 made 51 pounds or 10.3% more than lot 3. The great superiority of silage over dry fodder as a part of the ration is thus very evident from the standpoint of returns for feed actually eaten, but a very important part of the utility of silage is its small waste in feeding. While lot 2 ate 77.9% as much dry matter in silage as lot 3 ate in fodder, the total dry matter fed in silage was only 70.1% of the dry matter fed in fodder, thus the waste was much greater from the fodder.

Table I.

Summary of Feeds and Gains—Lot 1.

Periods.. Begining	Stover Refuse. A. M.	P. M.	Tot'ls	Stover Eaten. A. M.	P. M.	Tot'ls	She'd. Corn.	Cobs.	To.e'r Corn.	Glut'n Meal.	Total. Grain.	Cobs. Eaten	*Tot'l Rgh'e	Gain.
Steer 26.														
Dec. 14...	90.75	38.25	129.	161.25	99.35	260.6	217.6	45.6	263.2	56.	273.6	45.6	306.2	56
Jan. 11...	86.05	49.7	135.75	105.95	118.5	224.45	298.65	61.95	360.6	74.4	373.05	61.95	286.4	82
Feb. 8 ...	72.05	48.4	120.45	113.95	87.	200.95	351.35	77.15	428.5	94.8	446.15	77.15	278.1	40
March 8.	72.6	60.3	132.9	89.4	102.7	192.1	419.	92.	511.	102.2	521.2	90.9	283.0	82
April 5..	62.1	51.3	113.4	61.9	82.7	144.6	485.1	106.5	591.6	112.1	597.2	105.9	250.5	59
May 3...	60.15	51.	111.15	51.85	75.	126.85	514.55	112.95	627.5	109.1	623.65	107.45	234.3	61
Totals.	443.7	298.95	742.65	584.3	565.25	1149.55	2286.35	496.15	2782.4	548.6	2834.85	488.95	1638.5	380
Steer 33.														
Dec. 14...	117.9	38.75	156.65	134.1	78.15	212.25	197.	41.1	238.1	56.	253.	41.1	283.35	48
Jan. 11...	92.5	37.4	129.9	99.5	93.9	193.4	232.75	48.35	281.1	57.2	289.95	48.35	241.75	52
Feb. 8 ...	70.4	44.45	114.85	117.6	77.35	194.95	316.2	69.4	385.6	85.2	401.4	69.4	264.35	59
March 8.	88.	68.4	156.4	74.	66.6	140.6	372.2	81.7	453.9	94.4	466.6	81.45	222.05	36
April 5..	88.9	74.7	163.6	35.1	42.8	77.9	378.65	83.1	461.75	87.35	466.0	82.55	160.45	28
May 3...	79.65	83.1	162.75	32.35	42.9	75.25	419.9	92.2	512.1	89.1	509.0	92.	167.25	46
Totals.	537.25	346.8	884.15	492.65	401.9	894.35	1916.7	415.85	2332.55	469.25	2385.95	414.85	1509.2	269
Steer 29.														
Dec. 14...	118.55	27.8	146.35	126.25	64.1	190.35	173.1	35.8	208.9	56.	229.1	35.8	226.15	41
Jan. 11...	85.3	41.85	127.15	106.7	110.15	216.85	253.7	52.9	306.6	57.3	311.0	52.9	269.75	97
Feb. 8...	68.6	48.2	116.8	123.4	95.2	218.6	347.5	76.3	423.8	88.4	435.9	70.4	289.	45
Mar. 8...	74.9	67.45	142.35	87.1	95.55	182.65	368.55	80.9	449.45	81.25	449.8	64.85	247.5	21
April 5 ..	79.25	68.45	147.7	44.75	65.55	110.3	449.05	98.55	547.6	102.8	551.85	71.95	182.25	49
May 3 ...	66.25	63.35	129.6	45.75	62.65	108.4	467.75	102.65	570.4	99.2	566.95	82.7	191.1	49
Totals.	492.85	317.1	809.95	533.95	493.2	1027.15	2059.65	447.1	2506·75	484.95	2544.6	378.6	1405.75	302
Totals for lot 1.	1473.6	962.85	2436.75	1610.9	1460.15	3071.05	6262.6	1359.1	7621.7	1502.8	7765.4	1282.4	4353.45	951

*Total roughage is total stover, plus cobs eaten.

Summary of Feeds and Gains.—Lot 2.

Periods Beginning.	Stover Refuse. A. M.	P. M.	Tot'ls	Stover. A. M.	P. M.	Eaten Total	She'd. Corn.	Cobs.	Tot'ls Ear Corn.	Sil'ge Eaten	*Dry Rgh'e Total.	Cobs. Eaten	Total Gain
Steer 28.													
Dec. 14..........	119.25	....	119.25	132.75	....	132.75	129.35	24.65	154.	676.65	137.4	24.65	38
Jan. 11..........	77.6	....	77.6	114.4	....	114.4	180.75	34.45	215.2	638.9	148.85	34.45	64
Feb. 8..........	69.45	....	69.45	98.55	....	98.55	238.35	52.15	290.7	755.4	150.9	52.35	74
Mar. 8..........	94.2	9.6	103.8	67.8	6.4	74.2	334.55	73.45	408.	560.1	146.25	72.05	50
April 5..........	91.	82.45	173.45	28.5	38.55	67.05	422.85	92.85	515.7	....	156.15	89.1	9
May 3..........	69.15	69.25	138.4	42.85	56.75	99.6	423.1	92.9	516.	....	191.3	91.7	30
Totals......	520.65	161.3	681.95	484.85	101.7	586.55	1728.95	370.65	2099.6	2651.05	950.85	364.3	265
Steer 34.													
Dec. 14..........	97.9	....	97.9	154.1	....	154.1	129.35	34.65	154.	439.65	178.75	24.65	4
Jan. 11..........	73.2	....	73.2	118.8	....	118.8	180.75	34.45	215.2	487.9	153.25	34.45	33
Feb. 8..........	61.05	....	61.05	106.95	....	106.95	238.35	52.35	290.7	495.4	159.2	52.25	62
Mar. 8.........	63.95	6.6	70.55	98.05	9.4	107.45	334.55	73.45	408.	372.7	180.7	73.25	47
April 5..........	71.7	67.85	139.55	52.3	59.65	111.95	529.15	116.15	645.3	....	223.25	111.3	35
May 3..........	63.5	62.55	126.05	48.5	63.45	111.95	574.	126.	700.	-......	220.75	108.8	60
Totals......	431.3	137.	568.3	578.7	132.5	711.2	1986.15	427.05	2413.2	1795.65	1115.9	404.7	241
Steer 27.													
Dec. 14..........	133.1	....	133.1	118.9	....	118.9	129.35	24.65	154.	637.05	143.55	24.65	30
Jan. 11..........	92.75	....	92.75	99.25	....	99.25	180.75	34.45	215.2	471.15	125.1	25.85	12
Feb. 8..........	62.8	....	62.8	105.2	....	105.2	238.35	52.35	290.7	496.2	138.38	33.15	69
Mar. 8..........	75.7	6.6	82.3	86.3	9.4	95.7	334.55	73.45	408.	334.6	125.	29.3	65
April 5..........	74.4	60.95	135.35	49.6	65.55	115.15	509.2	111.8	621.	....	153.35	38.2	50
May 3..........	61.65	60.	121.65	50.35	66.	116.35	484.85	106.45	591.3	....	162.	45.65	32
Totals......	500.4	127.55	627.95	509.6	152.3	650.55	1877.05	403.15	2280.2	1939.	847.35	196.8	258
Totals for lot 2.	1452.35	425.85	1878.2	1573.15	386.5	1948.3	5592.15	1200.85	6793.	6385.7	2914.1	965.8	764

*Total dry roughage is total stover eaten, plus cobs eaten.

Table I—Continued.

Summary of Feeds and Gains—Lot 3.

Period.	Stover refuse (reduced.)			Stover eaten.			Shelled.		To.e'r	Cobs.	*Tot'l dry	Gain...
Beginn'g	A. M.	P. M.	Tot'ls	A. M.	P. M.	Tot'ls	Corn.	Cobs.	Corn.	Eaten	r'gh'e	
Steer 31.												
Dec. 14...	92.05	42.45	134.5	159.95	94.25	254.2	271.3	55.8	327.1	55.8	310.	15
Jan. 11...	88.05	46.65	134.7	103.95	97.25	201.2	330.1	67.2	397.3	67.2	268.4	33
Feb. 8...	66.8	47.35	114.15	122.2	80.95	203.15	394.15	86.55	480.7	85.2	288.35	55
March 8.	72.55	61.35	133.9	89.45	87.65	177.1	473.95	104.05	578.	90.6	267.7	51
April 5..	66.6	67.7	134.3	57.4	63.3	120.7	520.3	114.2	634.5	69.1	189.8	7
May 3...	56.35	58.9	115.25	55.65	67.1	122.75	528.1	115.9	644.	84.3	207.05	38
Totals..	443.4	324.4	766.8	588.6	400.5	1079.5	2517.9	543.7	3061.6	452.2	1531.3	199
Steer 30.												
Dec. 14...	95.95	31.75	127.7	154.05	85.15	239.2	251.6	51.5	303.1	51.5	290.7	10
Jan. 11...	83.75	46.05	129.8	108.25	108.65	216.9	340.9	69.6	410.5	69.6	286.5	61
Feb. 8...	76.35	62.35	138.7	114.65	76.35	191.	406.45	89.25	495.7	88.1	279.1	56
March 8.	76.15	75.1	151.25	85.85	73.9	159.75	473.95	104.05	578.	93.45	253.2	41
April 5..	63.4	60.6	124.	60.6	70.4	131.	553.9	121.6	675.5	105.35	236.35	55
May 3...	53.05	52.55	105.6	58.95	73.45	132.4	582.2	127.8	710.	84.05	216.45	44
Totals..	448.65	328.5	777.05	582.35	487.9	1070.25	2609.	563.8	3172.8	492.05	1562.3	267
Steer 32.												
Dec. 14...	493.7	36.8	130.5	158.3	81.	239.3	252.5	51.7	304.2	51.7	291.	25
Jan. 11...	90.6	48.15	138.75	101.4	104.75	206.15	339.1	69.2	408.3	65.8	271.95	41
Feb. 8...	63.75	48.45	112.2	128.25	93.15	221.4	410.25	90.05	500.3	59.6	281.	38
March 8.	66.95	68.05	135.	95.05	94.95	190.	487.75	107.05	594.8	72.95	262.95	71
April 5..	52.9	53.1	106.	71.1	80.9	152.	579.9	127.3	707.2	76.1	228.1	26
May 3...	51.3	53.7	105.	60.7	72.3	133.	642.9	141.1	784.	71.75	204.75	45
Totals..	419.2	308.25	727.45	614.8	527.5	1141.45	2712.4	586.4	3248.8	397.9	1539.75	246
Totals for lot 3..	1310.25	961.05	2271.3	1785.75	1505.45	3291.2	7839.3	1693.9	9533.2	1342.15	4633.35	712

*Total dry roughage is total stover eaten, plus cobs eaten.

If the silage had of been of first class quality there would have been practically no waste from it in feeding, where as in the present case the waste was 7%. Of the fodder 16% was wasted, but of course in each case it was the less palatable and least nutritious parts that were refused. Calculating from the figures given above the dry matter in silage fed being 70.1% of that in the fodder fed, and the gain from silage 10% more, 64 pounds dry matter in silage equalled 100 pounds dry matter in fodder. When we consider the fact that the waste in curing is greater in fodder than in silage the difference in favor of silage is made still more.

After silage feeding was discontinued the gains of the two lots were practically equal although No. 28 of lot 2 did very poorly. Lot 3 consumed more corn during this time so that for each 100 pounds gain during these last 8 weeks of the experi-

Table II.

Comparison of Fodder and Silage—Lot 2.

Period. Beginning.	Stover. Eaten	Stover. Ref'd.	Corn Fed.	Silage. Eaten	Silage. Ref'd.	Gain.	Dry Matter Eaten. Stov'r	Dry Matter Eaten. Corn.	Dry Matter Eaten. Sila'e	Dry Matter Eaten. Tot'ls	Per 100 lbs Gain.
Steer 28.											
Dec. 14	132.75	119.25	154.	676.65	61.35	38	108.2	126.9	214.5	449 6	1183.
Jan. 11	114.4	77.6	215.2	638.9	1.1	64	93.25	177.3	202.55	473.1	739.
Feb. 8	98.55	69.45	290.7	775.4	2.6	74	79.05	239.55	245 8	564.4	763.
Mar. 8	74.2	103.8	408.	560.1	.9	50	61.15	336.2	205.8	603.15	1206.
Totals	419.9	370.1	1067.9	2651.05	65.95	226	341.65	879.95	868.65	2090.25	925.
Steer 34.											
Dec 14	154.1	97.9	154.	439.65	137.35	4	125.6	126.9	139.35	391.85	9796.'
Jan. 11	188.8	72.2	215.2	487.9	18.1	33	96.8	177.3	154.65	428.75	1299.
Feb. 8	106.95	61.05	290.7	495.4	12.6	62	85.75	239.55	157.05	482.35	778.
Mar. 8	107.45	70.55	408.	372.7	24.3	47	88.55	336.2	137.7	562.45	1197.
Totals	487.3	302.7	1067.9	1795.65	192.35	146	396.7	879 95	588.75	1865.4	1278.
Steer 27.											
Dec. 14	118.9	133.1	154	637.05	90.95	30	96.9	126.9	201.95	425.75	1419.
Jan. 11.	99.25	92.75	215.2	471.15	24.85	12	80.9	177.3	149.35	407.55	3396.
Feb. 8	105.2	62.8	290.7	496.2	30.8	69	84.35	239.55	157.3	481.2	697.
Mar. 8	95.7	82.3	408.	334.6	44.4	65	78.85	336.2	122-55	537.6	827.
Totals	419.05	370.95	1067.9	1939.	191.	176	341.	879.95	631.15	1852.1	1052.
Total for Lot 2	1326.25	1043.75	3203.7	6385.7	449.3	548	1079.35	2639.85	2088.55	5807.75	1060.

Comparison of Fodder and Silage, Lot No. 3.

Period. Beginn'g	Stover Eaten	Stover Ref'd.	Corn Fed.	Fodder. Eaten	Fodder. Ref'd.	Fod'r Fed.	Gain.	Dry Matter Eaten. Stov'r	Dry Matter Eaten. Corn.	Dry Matter Eaten. Fod'r	Dry Matter Eaten. Tot'ls	Per 100 lbs Gain.
Steer 30.												
Dec. 14	159.95	92.05	154.	267.35	42.45	309.8	15	130.35	126.9	219.	476.25	3175.
Jan. 11	103.95	88.05	215.2	279.35	46.65	326.	33	84.7	177.3	228.75	490.75	1487.
Feb. 8	108.65	59.4	290.7	284.5	54.75	339.25	55	87.15	239.55	232.35	559.05	1016.
March 8.	98.85	79.15	408.	248.25	54.75	303.	51	81.45	336.2	204.55	622.2	1220.
Totals	471.4	318.65	1067.9	1079.45	198.6	1278.05	154	383.65	879.95	884.65	2148.25	1395.
Steer 31.												
Dec. 14	154.05	95.95	154.	234.25	31.75	266.	10	125.55	126.9	191.85	444.3	4443.
Jan. 11	108.25	83.75	215.2	303.95	46.05	350.	61	88.2	177.3	248.8	514.3	843.
Feb. 8	100.9	67.2	290.7	295.1	71.5	366.6	56	80.9	239.55	241.2	561.65	1003.
March 8.	93.8	84.2	408.	235.95	67.05	303.	41	77.3	336.2	194.4	607.9	1483.
Totals	457.	331.1	1067.9	1069·25	216.35	1285.6	168	317.95	879.95	876.25	2128.15	1267.
Steer 32.												
Dec. 14	158.3	93.7	154.	231.2	36.8	268.	25	129.	126.9	189.35	445.25	1781.
Jan. 11	101.4	90.6	215.2	297.85	48.15	346.	41	82.65	177.3	243.85	503.8	1229.
Feb. 8	112.2	55.8	290.7	318.8	56.4	375.2	38	90.	239.55	260.3	589.85	1552.
March 8.	104.35	73.6	408.	272.45	61.4	333.85	71	86.	336.2	224.5	646.7	911.
Totals	476.25	363.7	1067.9	1120.3	202.75	1323.05	175	387.65	879.95	918.	2185.6	1249.
Totals for lot 3	1404.65	963.45	3203.7	3269.	617.7	3886.7	497	1143.25	2639.85	2678.9	6462.	1300.

ment lot 3 required 1585 pounds grain and lot 2 only 1363 pounds grain.

Table III. gives different statements of the weights of feed eaten per 100 pounds gain. From this comparison can be made between the individual steers and the lots, and also this

TABLE III.

FEED EATEN 100-LB. GAIN.

Steer No.	Gain.	Stover	Silage	*Ear Corn.	Gluten Meal.	Ear Corn Glu. Meal	†Grain Alone.	Cobs Eaten.	Total Dry Roughage.
Lot No. 1.									
26	380	302.	....	732.	144.	877.	746.	129.	431.
33	269	332.	....	867.	174.	1042.	887.	154.	487.
29	302	340.	....	830.	161.	991.	843.	125.	465.
Total	951	323.	....	801.	158.	959.	817.	135.	458.
Average	317	325.	....	810.	160.	970.	825.	136.	461.
Lot No. 2.									
28	265	221.	1000.	792.	....	....	652.	137.	359.
34	241	295.	745.	1001.	....	....	824.	168.	463.
27	258	252.	752.	884.	....	....	728.	76.	329.
Total	764	256.	836.	889.	....	....	732.	126.	381.
Average	255	256.	832.	892.	....	....	735.	127.	384.
Lot No. 3.									
31	199	542.	....	1538.	....	....	1265.	227.	769.
30	267	401.	....	1188.	....	....	977.	184.	585.
32	246	464.	....	1341.	....	....	1103.	162.	626.
Total	712	462.	....	1339.	....	....	1101.	189.	651.
Average	237	469.	.	1356.	....	....	1115.	191.	660

*Ear corn takes no account of cobs left.
†Grain alone refers to corn as shelled corn.

data can be used in comparing the results of this experiment with others.

It should be born in mind in studying this table that the grain recorded for lot 2 takes no account of that which it received in silage. It appears that the steers were fairly uniform feeders. No. 28 is much below the others of his lot in grain required for 100 pound gain but this is in part offset by his greater amount of silage. In lot 3 No. 30 is decidedly a better feeder than 31 or 32. In general the amount of grain required for 100 pounds gain is fully as low as in most other feeding tests showing that the steers were thrifty feeders.

Table IV. gives data of the shipping and slaughtering of the animals. Notice that in order of totals, dressed weight per cent, weight of liver and weight of internal fat the lots stand

Nos, 1, 2, 3. Altho lot 1 steers were the fattest yet their greater gains were partly due to increased growth as compared with the other lots, for they showed perceptibly greater height and length than the steers of the other lots, at the close of the experiment. The steers were sold to Swift & Co. and to their kindness we are indebted for the data in table IV. Their

Table IV.

Data Procured in Slaughter Tests.

	No. 26	33	29	Total Lot 1.	28	34	27	Total Lot 2.	31	30	32	Total Lot 3.
Live Wt., Champaign. May 30	1368	1195	1139	3702	1242	1171	1140	3559	1179	1242	1087	3508
Live Wt, Chicago, June 1	1360	1220	1140	3720	1250	1170	1140	3560	1160	1260	1080	3500
Gain	......	25	1	18	8	......	......	1	......	18	......	......
Shrink	8	......	......	......	......	7	......	......	19	......	7	8
Dressed wt	840	719	684	2243	743	655	680	2078	660	745	614	2019
Per cnt. drs'd wt	61.76	58.93	60.0	60.3	59.44	55.98	59.65	58.37	56.9	59.13	56.85	57.69
	lb.oz.	lb.oz	lb.oz.	lb.oz.	lb.oz.	lb.oz.	lb.oz.	lb.oz.	lb.oz.	lb.oz.	lb.oz.	lb.oz.
Wt. of hide	85	87	77	249	87	81	78	246	77—8	83—8	74	235
Wt. of heart	5—8	4—15	4—12	15—3	4—8	4—5	4—4	13—1	5—	4—15	4—11	14—10
Wt. of liver	15—8	13—4	12—9	41—5	11—4	12—1	12—6	35—11	10—5	11—12	10—9	32—10
Wt. of inter. Fat.	64—10	51—13	52—9	169	42—	41—12	36—8	120-4	41—13	45—14	31—1	118-12

butchers considered that the fat of all the steers of a good white color, of a good quality, and no difference between the steers. As to the external covering of fat steers Nos. 28, 30, 33 and 29 were best. Nos. 26, 27, 31, 34 were not so good, while No. 32 was poorly covered on flanks and back. The average price received for the steers shows a distinct difference between the lots in favor of those steers which did the best feeding. The average price per 100 pounds for lot 1 was $4.93⅓; lot 2, $4.85; lot 3, $4.76⅔.

Owing to peculiar circumstances, often attendant upon an experiment of this kind, the financial statement shows a loss instead of a profit, but still the statement is of interest as showing the conditions as they existed at the time and how the behavior of the different lots affected their financial return. More than market price had to be paid for the steers in order to get privilege of selection; then too the steers were bought at a time when the feeder market was disproportionately high; and the steers had to be sold before they were fully fattened and on a sluggish

market. Listing steers and purchased feed at their actual prices we have the following financial statements:

LOT I.

Cost of 3 steers, 27.51 cwt @ $5		$137.55
Cost of 1503 lbs gluten meal @ $20 per T.		15.03
Sold 3 steers:		
No. 26—13.60 cwt @ $5	$ 68.00	
No. 33—12.20 cwt @ 4.90	59.78	
No. 29—11.40 cwt @ 4.90	55.86	
	$183.64	
Received for 111.8 bu corn and 2.75 tons stover		31.06
		$183.64

Disregarding stover, corn equals 28c per bu.

LOT II.

Cost of 3 steers, 27.95 cwt @ $5		$139.75
Sold 3 steers:		
No. 28—12.50 cwt @ $4.85	$ 60.62	
No. 34—11.70 cwt @ 4.85	56.75	
No. 27—11.40 cwt @ 4.85	55.29	
	$172.66	
Received for 99.9 bu corn, 3.42 tons silage and 1.91 tons stover		32.91
		$172.66

LOT III.

Cost of 3 steers, 27.96 cwt @ $5		$139.80
Sold 3 steers:		
No. 31—11.60 cwt @ $4.65	$ 53.94	
No. 30—12.60 cwt @ 5.00	63.00	
No. 32—10.80 cwt @ 4.65	50.22	
	$167.16	
Received for 140 bu corn and 2.78 ton stover		27.36
		$167.16

Disregarding stover, corn—20c per bu.

It is impossible to set a definite valuation upon the stover and silage and at any rate the most satisfactory way of treating feeds raised on the farm is to determine their selling price, through the medium of the animals rather than to charge them at arbitrary prices. As lots 1 and 3 were fed practically the same amount of stover it can be disregarded in the comparative calculation and we have a resulting difference of 8c per bu. of corn in favor of lot 1. Disregarding stover and computing the corn fed lot 2 at the price obtained for it through lot 3 we have $3.78 per ton for silage; figuring it at the price obtained through lot 1, we have $1.44 per ton for the silage. The former price for silage is a very high one showing much superior returns from lot 2 as compared with lot 3; while the latter price is low. If lot 2 had eaten as much stover as the other lots the consumption silage would have been reduced somewhat and the valuation of silage on this basis of computation would have been correspondingly enhanced. This would bring lots 1 and 2 quite close together financially. Thus comparing the 3 lots, on financial returns we find that lots 1 and 2 each were much ahead of lot 3 and that lots 1 and 2 were nearly equal.

What the result would have been if lot 2 had been supplied protein in addition to that furnished by the corn ration, can only be conjectured. The increased gains of lot 1 were presumably due to the addition of protein to the otherwise simple corn ration, while the greater returns from lot 2 were due to the most acceptable form in which the nutriments of the corn diet were furnished by the silage. Probably a combination of these two rations would have given at least somewhat better results than either alone.

The pigs which followed the steers proved very uneven, some pigs in each lot doing so poorly that no conclusions of value can be reached from the results of their feeding. Suffice it to say that a total of 804.75 pounds gain was made by the 3 lots of pigs following the 3 lots of steers, the additional grain feed of the pigs being 192 lbs. for each 100 lbs. gain. A check lot fed grain alone required 604 lbs. grain for each 100 lb gain. It thus appears that the pigs utilized about 15% of the grain fed the

steers. This demonstrates anew the well understood fact that pigs should follow steers fed whole corn.

The experiment has indicated at least:

(1.) That satisfactory results with steers attend the use of corn stover alone as roughage and corn as the principal grain rations, supplemented with a highly nitrogenous feed to make the nutritive ration about 1:7.5.

(2.) That if the corn crop alone is to be used for steer feeding the results are much better if part of the crop is made into silage.

(3.) That corn and corn stover alone give comparatively poor results in steer feeding.

THE INTERCOLLEGIATE LIVE STOCK JUDGING ASSOCIATION.

By C. H. Fellingham, Class of 1901.

One of the most distinctive and fruitful movements in agricultural education of the past year, was the organization of the Intercollegiate Live Stock Judging Association. At a meeting held in Chicago, November 1, 1901, professors and instructors from agricultural colleges of the Middle West organized this association.

Desiring to keep pace with the literary colleges in promoting rivalry for high class honors by means of intercollegiate contests, and to show the advantages of combining the theoretical with the practical, the organization provides for annual contests in live stock judging. These contests are open to students of agricultural colleges of the United States and Canada, and presumably will be held at the International Stock Show. Individual and class prizes are offered to the best judges as determined

by expert stockmen, who will pass upon the animals, and mark the students according to the method and proficiency of judging. The system of marking used, is as follows: Fifty per cent. (50%) for correct placing, thirty per cent. (30%) for reasons for placing, ten per cent. (10%) for method of examination, and ten per cent. (10%) for time taken. The limit of time will be thirty minutes, with one point deducted for every minute used over twenty.

The first contest, held on Friday, Dec. 7, 1900, at the International Stock Show, was a success in every respect. Through the efforts of the executive committee, fifty-three young men entered the contest, and fully five hundred fellow students were on the grounds during the week, each anxiously awaiting the struggle in which the representatives from his college would compete with those from other institutions. Prizes to the value of over six hundred dollars had been offered. Mr. John A. Spoor, president of the Union Stock Yards and Transit Co., was the donor of the Spoor Trophy, to be awarded annually to the institution making the highest aggregate score with three representatives. Mr. Spoor first tried to get the famous bronze ox, done by Isadore Bonheur, but failing in this, he ordered a duplicate, made by Mr. Tiffany of France. One hundred and fifty dollars for sweepstakes prizes were given by the Breeder's Gazette. Among the breeding associations, the Hereford gave $100.00, the Shropshire, $35.00, and the Dorset and Cotswold, $25.00 each. Mr. R. D. Burnham, a prominent breeder of Champaign, Ill., contributed $75.00 to the general fund, and the National Stockman donated $25.00 for swine judging.

The following list will show to whom the prizes were awarded.

Prizes awarded at First Inter-Collegiate Judging contest, Chicago, 1900.

ANIMALS	CLASS	STUDENTS	INSTITUTION	POINTS	PRIZE.
Horses	2-year-old Clydesdale Stallion	S. J. Haight	Illinois University	258½	$10 00
	Aged Percheron Stallions	J. P. Finch	Illinois University	255½	7 00
	Market Draft Horses	Geo. E. Camp	Illinois University	242	5 00
		G. M. Richardson	Illinois University	239¼	3 00
Cattle	Aged Hereford Bulls	E. L. Worthen	Illinois University	200	30 00
	Yearling Hereford Heifers	W. J. Black	Ontario Agr. Coll	190¾	25 00
		Van Pelt	Iowa Agr. Coll	182	20 00
		G. R. Camp	Illinois University	172	15 00
		Julius Ensminger	Purdue University	171⅝	10 00
Sheep	Aged Shropshire Ewes	Arthur Banks	Wisconsin Univer'	100	15 00
		V. N. Shoesmith	Mich. Agr. Coll	95	10 00
		E. P. Welborn	Wisconsin Univer'	93½	6 00
		J. S. Cummings	N.Dakota Agr.Coll	92	4 00
Sheep	Aged Cotswold Ewes	W. J. Black	Ontario Agr. Coll	81½	10 00
		Geo. Severance	Mich. Agr. Coll	80½	7 00
	⅓ each	Thomas Hunt	Iowa Agr. Coll		
		C. E. Hoyman	Iowa Agr. Coll	78⅓	5 00
		E. L. Worthen	Illinois University		
		M. S. McClure	Wisconsin Univer'	77⅓	3 00
		E. T. Robbins	Illinois University		
Sheep	Dorset Ewe Lambs	Chas. Frazier	Purdue		
		A. E. Wade	Illinois		
		E. P. Welborn	Wisconsin $2 50 each	73⅓	10 00
		H. W. Britell	Iowa		
		Arthur Danks	Wisconsin Univer'	71⅓	7 00
		Thomas Hunt	Iowa Agr. Co l	70⅓	5 00
		W. J. Black	Ontario Agr. Coll	69⅓	3 00
Swine	Poland China Sows Aged. Bacon Pigs. Fat Pigs	G. R. Camp	Illinois University	219⅔	10 00
		Chas. Frazier	Purdue University	214½	7 00
		W. J. Black	Ontario Agr. Coll	210⅓	5 00
		N. A. McCune	Mich. Agr. Coll		
		E. P. Welborn	Wisconsin Univer'	205⅓ ($1 50	3 00
Sweepstakes	Sweepstakes (1)	E. P. Welborn	Wisconsin Univer'	935⅓	40 00
	(2)	G. R. Camp	Illinois University	921⅔	35 00
	(3)	W. J. Black	Ontario Agr. Coll	875¼	30 00
	(4)	E. T. Robbins	Illinois University	864	25 00
	(5)	Chas. Frazier	Purdue University	861⅝	20 00
	(6)	H. W. Britell	Iowa Agr. Coll		17 50
	(7)	G. C. Humphrey	Mich. Agr. Coll	838⅝	15 00
	(8)	M. S. McClure	Wisconsin Univer'	828½	7 50

SPOOR TROPHY CUP

For aggregate score of three best students. } ILLINOIS UNIVERSITY.

BANNER

For institution whose representative wins first place. } WISCONSIN UNIVERSITY.

We, the undersigned in charge of the judging records certify that the above records are correct to the best of our knowledge and belief.

C. S. PLUMB,
W. J. KENNEDY,
H. W. MUMFORD,
JOHN A. CRAIG.

December 9, 1900.

Thus we see that the University of Illinois won the Spoor Trophy, valued at $200.00, and $145.65 in cash, a sum total of more than all prizes awarded to other colleges. In the classes of horses Illinois won every prize. Mr. S. J. Haight taking first, Mr. J. P. Finch, second, Mr. Geo. R. Camp, third, and Mr. G. M. Richardson, fourth prizes. Mr. E. L. Worthen deserves special mention for his excellent work in the two Hereford classes. Having had no experience with live stock, except a few months training at the university, he scored 100 in both classes. Wisconsin was the leader in sheep, but Illinois was a close second, winning two firsts with Wade and Camp, a third with Worthen, and a fourth with Robbins. In Poland China hog classes, Camp of Illinois was awarded first prize, although Welburn of Wisconsin received first prize in the sweepstakes class, yet, Camp was second and Robbins, fourth, thus Illinois won more in this class than any other institution.

The following table is a summary of the work of the representatives of each college.

NAME OF INSTITUTION.	NO. MEN ENTERED.	NO. MEN WON PRIZES.	NO. PRIZES WON.	VALUE OF PRIZES.
University of Illinois,	9	7	13	$345 65
University of Wisconsin,	8	3	8	87.50
Ontario Agricultural College,	1	1	5	73 00
Iowa Agricultural College,	11	4	6	49.32
Purdue University,	7	2	4	39.50
Michigan Agricultural Coll.,	8	4	4	33.50
N. Dakota Agricultural Coll.,	1	1	1	4.00
Missouri University,	6	0	0	

This contest proves that the University of Illinois is a leader among the colleges of the United States and Canada, and as such, has made a record of which every citizen of the state ought to be proud.

"Without proper care the most expensive road may go to ruin in two or three years, and the initial expense of constructing it be nearly lost. It is of greatest importance, therefore, that all good roads should have daily care. They not only wear out, but wash out and freeze out. Water is the greatest road destroyer.

It is necessary to the proper maintenance of a road that it should "crown" or be higher in the middle than at the sides. If it is flat in the center it soon becomes concave, and its middle becomes a pool or a mud hole if on a level or a water course if on an incline.

A hollow, rut, or puddle should never be allowed to remain, but should be evenly filled and tamped with the same material of which the surface was originally constructed. A rake should be used freely, especially in removing stones, lumps, or ridges. Ruts may be avoided by using wide tires on all wagons which carry heavy loads. If this is not always possible, the horses should be hitched so that they will walk directly in front of the wheels. This can be accomplished by making the double, or whiffle, tree of such length that the ends may be in line with the wagon wheels. A horse will not walk in a rut unless compelled to do so, and, consequently, if all horses were hitched in this way ruts would eventually disappear from stone roads.

If stones are cracked on a road with a hammer a smooth surface is out of the question. Use stone chips for reparing stone roads, and remember that all foreign material and rubbish will ruin the best road, and that dust and mud will double the cost of maintenance.

Ordinarily the chief work done by country people on highways is repairing the damage resulting from neglect. Why this negligence? The adage, "A stitch in time saves nine," can never be applied more appropriately to anything than to the maintenance or repair of all kinds of roads."—Maurice O. Eldridge, on the "Construction of Good Country Roads" in the Year Book of the United States Department of Agriculture for 1898.

The First Successful Reaper Made by Cyrus McCormick in 1832.

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PREFACE.

The Agricultural Club of the University of Illinois presents to the people of the state its sixth annual publication with the hope that it may in some measure represent the grade and character of the work done by the students of the College of Agriculture, that it may bear evidence to the people of Illinois of the excellence of the instruction provided their sons at the State University, and that it may be recognized as an expression of a love of rational agriculture.

We take great pleasure in thanking our contributors for their labor in behalf of agriculture, and also thank our advertisers for their generous support.

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BREEDING CORN FOR IMPROVEMENT IN COMPOSITION.*

By C. G. Hopkins, Ph.D., Professor of Agronomy.

The word *corn*— which comes into the English language directly from the Anglo-Saxon, and which occurs with nearly the same spelling and pronunciation in several other modern languages which are also derived in part at least from the Anglo-Saxon, as the German, Danish, Dutch, Swedish, and Norwegian —is by no means an original or specific name of the grain which we call corn.

In its broadest sense the word corn is almost synonymous with the word *grain*, and in the old countries it is frequently still used to denote all those kinds of grain which serve as food for man and the domestic animals—as wheat, oats, barley, rye, rice, and what we call corn. But in most countries the word corn has also a specific meaning in which it is used to designate some particular kind of grain; and it is commonly used as the name of that particular kind of grain which constitutes, or which at some time has constituted, the chief breadstuff for the people of that land. If we include the grain food for the domestic animals, this specific use of the word corn holds for the United States today; and, of course, during the early colonial times corn did constitute the chief breadstuff of this country. In England the only specific meaning of the word corn is wheat; in Scotland it is applied to oats; while in Germany the word *Korn* means rye, which is still the chief breadstuff of the German people.

The specific name for corn is the word *maize*, which is evidently derived from the original name given to it by the Indians of the West India Islands; that is, *mahis*. The Spaniards who carried the grain from the West Indies to Spain called it *mais*. In French it is called *mais*; in German *mais*; and in English *maize*.

While some claim has been made that corn, or maize, was

*For more complete information concerning the progress of these experiments consult the bulletins of the Illinois Agricultural Experiment Station.

grown in the old world prior to the discovery of America, there is but little if any foundation for such a claim; and it appears to be an established fact that the nearest approach to corn found native in the Old World is a coarse variety of millet. That corn is a native of America is beyond question. It was first discovered on several of the West India Islands by Columbus on his first voyage to America, and was also found in a state of cultivation in most of the places in both North and South America where the first navigators landed.

One of these early explorers, Gonzalo Ximenes, speaking of the land which was called New Grenada, said: "The principal food of the natives was maize, which grows on stalks of the size of canes, bearing very large and weighty spikes, or ears, each generally yielding seven hundred grains, a bushel of which, when planted in warm, moist land frequently produces 300-fold." As it would require 14 rows of kernels with 50 kernels in the row to make an ear of seven hundred grains, it can be seen that the ear of corn produced in the torrid zone by the Indians 400 years ago was about as large as we usually produce to-day in Illinois; and if they planted it as thickly as we do, the 300-fold would mean at least 50 bushels yield per acre.

From Jos. de Acasti's Natural History of the West Indies is quoted the following statement: "[Maize] was the only grain found in the West Indies by the European. It grows upon a long reed with large grains and sometimes two ears on a reed, on one of which 700 grains have been told. They sow it grain by grain, and not scattering as is done with wheat, and it requires hot and moist soil. The Indians eat it hot, boiled, and sometimes toasted. They also grind it and make cakes, which they eat hot. They also make bread to keep, and sweet cakes of it. They have also a way of extracting oil from it which is good, and serves instead of butter and olive oil." The fact that corn oil serves instead of olive oil seems to have been well remembered by the Spanish and by the French and Italians also; and now our own people have rediscovered a method of extracting the oil from corn, and we are exporting it in considerable quantities to Spain and France and Italy, and without doubt buying it back to "serve as olive oil."

Nearly 300 years ago Governor John Winthrop, the founder of Boston (1630), speaking of corn in a letter to the Royal Society of London, said: "The natives call it *wiachin* and in some southern parts of America it is known by the name of mais or maize. The ear is a span (9 inches) long, composed of eight rows of grain, or more, according to the goodness of the ground, about 30 grains in a row. It is of various colors, such as red, white, yellow, blue, olive, greenish, black, speckled, striped, sometimes in the same field and in the same ear. The stalks grow six or eight feet high; that of New England is not so tall as Virginia, and at Canada it is shorter than in New England."

Of the first settlement in Maryland one writer says: "There was Indian corn enough in the country, and these new adventurers soon after shipped 10,000 bushels for New England to purchase salt fish and other provisions."

Vega, an early writer on the people and products of Peru, says: "Of the fruits that grow above ground, the chief and principal is that grain which the people of Mexico and Barlovento call *mayz*, and those of Peru *cara*, being the only bread they use. Of the flour of maize mixed with water, the Indians brewed their common beverage—and some, who loved to be drunk, lay their corn steeping in water until germination took place, and then, after grinding, boiled it in the same water, drained it off, and kept it until stale. From its intoxicating effects, its use was prohibited by the Incas, who made it a penal offence with all who drank to excess."

Captain John Smith, in his account of the Indians of Virginia says: "The greatest labor they take is in planting their corne. To prepare the ground they bruise the bark of the trees near the root, then doe they scortch the roots with fire, that they grow no more. The next year with a crooked piece of wood they beat up the weeds by the roots, and in that mould they plant their corne. Their manner is this: they make a hole in the earth with a stick and into it they put foure graines of wheat [maize]. These holes they make foure foote one from another. Their women and children doe continually keepe it with weeding, and when it is growne middle high, they hill it about like a hop-yard. In Aprile they begin to plant, but their chief plantation

is in May, and so they continue till the midst of June. What they plant in Aprile, they reape in August; for June, in October. Every stalke of their corne commonly beareth two ears, some three, seldom four, many but one, and some none. Every eare ordinarily hath betwixt 200 and 500 graines. Their corne they roast in the eare green. Their old maize they first steepe a night in hot water, in the morning pounding it in a mortar. Tempering this flour with water they make it either in cakes or boyle in water."

The proof of the American origin of corn seems conclusive from the fact that the plant is still found in this country in its indigenous or wild state. It has been noticed by several botanists in the southwestern part of North America, in Central America, and in South America. Among the latest of these observations is that of Professor Watson, of Harvard University. In 1891 he described a wild corn plant from the mountainous districts of Southern Mexico, under the name of *Zea canina*, or coyote corn, which he believed to be the original wild corn, the parent form of maize, or Indian corn. It is a plant much like common field corn in many respects. The stalks are tasseled at the top, and the ears, inclosed in husks, are borne at the sides of the stalks as in the common forms of corn, but the ears are very small, being only about two inches long, and they have but four rows of kernels. The "cob" of this wild corn is small and jointed, and when fully ripe it breaks up into as many pieces as there are grains on the ear, the pieces of cob remaining attached to the grain, and because of this the grains are more easily blown about by the wind. Sometimes the grains are inclosed in little individual pods, or husks, which enable them to float on water. Thus the wild corn still retains a form which insures self-dissemination.

But if this wild coyote corn is the true ancestor of our field corn, as is doubtless the case, then the fact becomes established that the Indian, through the long centuries during which he cultivated, developed, and bred corn, did vastly more to improve the plant than the white man has since accomplished.

The first experiments in corn breeding were certainly conducted by the Indians. An Indian tradition tells of the method

by which the varieties of corn were obtained which are able to develop to maturity in the northern states. Corn was a native of warm climates. To cultivate it in the north, where the season was short, required that a new variety be developed which would grow and ripen between the frosts of spring and autumn. The Indians observed that corn, like all the grasses and like many other annual plants, grows upward by joints or sections. They observed that the time required to produce and perfect a joint was one change of the moon, and, as the ear of corn starts only from the joint, there were necessarily about seven days between the forming of the ears on successive joints. Now, said the Indians, if an ear could be made to start at the sixth joint it would reach maturity seven days in advance of an ear which should be formed on the seventh joint, and if it could be made to grow on the second or third joint it would ripen a whole moon earlier than that on the sixth or seventh joint. And they constantly selected seed from the lowest ears they could find and finally produced varieties whose ears grow from joints lower than in the original plant and mature much earlier. That they have made other improvements by breeding corn is proved by the fact that even in the north they produced ears of corn 8 to 9 inches long and with at least 8 rows of kernels, while in the southern countries the ears bore as many as 700 kernels, which must have been equal to much of the corn which is now grown.

But the white man has certainly made some improvement in corn. He has continued to increase the yield and to push back the northern boundary of the great corn belt, so that even the states of Minnesota and South Dakota are rapidly changing from wheat to corn states and each is already producing 30 to 40 million bushels of corn *per annum*, whereas twenty to thirty years ago corn was frequently considered too doubtful a crop in those states to risk the planting. But if we do no more than to produce varieties for northern climates and to increase the yield of corn, we only follow in the footsteps of the red man. If corn served but a single purpose and if it were perfectly suited to this use, then we might be satisfied simply to increase the yield of corn; but as a matter of fact the uses of corn are manifold and they are multiplying as the years go by. It is no longer valued

solely as the grain, corn, but for the several different constituents which it contains.

For convenience these constituents may be classed in four groups: (1) the *carbohydrates*, which include the starches, pentosans, celluoses, and sugars; (2) the *protein*, containing the albuminoids and other nitrogenous bodies; (3) the *fats*, composed of various oils and allied substances; and (4) the mineral elements, which, in the case of corn, consist largely of the valuable elements of fertility, potassium and phosphorus.

The following table shows the average composition of Burr's White corn, the variety with which the results in corn breeding which are summarized below, were obtained.

AVERAGE PERCENTAGE COMPOSITION OF ORDINARY BURR'S WHITE CORN.

Carbohydrates	Protein	Oil	Ash
82.95	10.92	4.70	1.43

For use in fattening cattle the ordinary composition of corn is not nearly perfect, although it is commonly thought to be very good for fattening hogs; but for the growing stock, where flesh forming and muscle building are desired, for the dairy cow, whose highest milk production is sought, or for poultry feed for the production of eggs, corn is decidedly deficient in that class of nitrogenous substances which we call *protein*, because to build muscle, to form flesh and many other animal tissues, or to produce milk or eggs, requires a larger proportion of protein than corn contains. For many feeding purposes corn is far from what the stockman calls a *balanced ration*.

But there are still other objections to the present composition of ordinary corn for certain uses. As already stated, corn is commonly thought to be a very good food for fattening hogs, and it might be supposed that the high content of fat or oil in corn was a point in its favor for this use; but recent researches have shown that in some instances, at least, such a supposition is very incorrect.

While in Germany a year ago, the writer learned that the German people strongly object to the use of corn for fattening hogs because it contains too much oil and produces pork which makes too soft bacon and sausage. Incidentally it may be said

that bacon and sausage, particularly the latter, constitute the chief part of the meat diet of the German people. Their meat shops contain about as many kinds of sausage as our drug stores do of patent medicines, and when they say sausage is too soft they speak whereof they know. They have not only discovered that corn produces soft pork, but they have conducted experiments and are now able to tell us just the reason for the production of soft pork; that is, because the corn contains such a high percentage of liquid fat, or oil. The Germans are now substituting other grains and foodstuffs for American corn as far as possible in feeding hogs. We still supply Germany with about 50,000,000 bushels of corn annually, not because they prefer it but simply because it is the cheapest foodstuff they can obtain.

Even in Canada is found a similar state of affairs; not that the Canadians themselves object so much to soft bacon and sausage, but they furnish pork for the British market, and it seems that the British people have about the same notions regarding soft pork as the Germans have. And the Canadians have not only learned that soft pork brings a lower price in the British market, but they, too, have conducted elaborate and exhaustive experiments (for our benefit) which confirm the results obtained in Germany and seem to show conclusively that soft pork is produced by feeding corn, and that the cause is the high percentage of oil which the corn contains. They, too, are substituting as far as possible other grains, such as barley and rye, for our American corn for pork production.

But still other objections have been made to the present composition of corn. Immense quantities of this grain are used for the manufacture of starch, glucose syrup, and the alcohol used in the arts and sciences besides that which is used to make various kinds of liquors. For all of these purposes only the carbohydrates can be used. The protein is considered as an impurity, and at best becomes a by-product of lower value than the starch or other chief product. Formerly for all of these industries the oil in corn was objectionable, and in some of them it is still a waste product; but in the starch and glucose factories methods have been adopted by which the oil of corn can be separated in a very pure form; and as the oil is worth more per pound than either

starch or glucose, the manufacturers now want corn with as high a percentage of oil as possible, as may be seen from the following extract from a recent publication of the Glucose Sugar Refining Company:

"Assuming that the average crop of corn produced in Illinois amounts to 200,000,000 bushels annually, and that 80 per cent. of this yield never leaves the farm, this state would produce a corn surplus of 40,000,000 bushels every twelve months.

"During the month of October, 1899, this company ground 1,900,000 bushels of corn in its three Illinois factories, for which it paid approximately $582,000. It is safe to assume that 75 to 80 per cent. of this quantity was grown on Illinois farms. If these statistics are correct, the three factories operated by this company, located at Chicago, Peoria, and Rockford, respectively, consumed nearly half of last year's surplus of Illinois corn.

"A bushel of ordinary corn, weighing 56 pounds, contains about 4½ pounds of germ, 36 pounds of dry starch, 7 pounds of gluten, and 5 pounds of bran or hull, the balance in weight being made up in water, soluble matter, etc.

"The value of the germ lies in the fact that it contains over 40 per cent. of corn oil, worth, say, five cents per pound, while the starch is worth one and one-half cents, the gluten one cent, and the hull about one-half cent per pound.

"It can readily be seen that a variety of corn containing, say, one pound more oil per bushel would be in large demand.

"Farmers throughout the country would do well to communicate with their respective agricultural experimental stations and secure their coöperation along these lines."

As a matter of fact there is now an actual demand for several different kinds of corn of different composition. For some uses more carbohydrates are wanted, and for other uses less carbohydrates. The feeders want more protein, the factories want less protein. The starch and glucose people want more oil in corn, the German and Canadian pork raisers want less oil.

The quite extended investigation of the chemistry of corn begun by the writer some six years ago had for its object the devising of methods for conducting experiments to improve the chemical composition of the grain.

It has long been known that the mineral content of plants can be changed to some extent by the addition to the soil of mineral materials in a form readily available to the plant, and it is probable that differences in the fertilizing elements of the soil may even affect the percentage of some organic constituents of the plant; but that any temporary change thus effected would have an hereditary tendency seemed unlikely. The method of procedure which seemed most promising is based upon the common method of making improvement in animals; namely, selecting the best examples of the desired type and breeding successively and under the best conditions from that stock. This is practically the method by which the sugar content of certain varieties of beets has been changed from three to four per cent. to twelve, fourteen, and sixteen per cent.; and this single example of a marked change having been effected in the composition of a plant was an encouragement to believe that something could be done in the way of improving the chemical composition of corn.

In the work with sugar beets a small portion of the beet is analyzed; and if it is found to be sufficiently rich in sugar, the beet is planted as a "mother," or seed beet. From the seed produced, beets are grown, and thus successive selections are made on the basis of sugar content.

In the preliminary study of the composition of corn, two important facts were established:

1. The ear of corn is approximately uniform throughout in the composition of its kernels.

2. There is a wide variation in the composition of different ears in the same variety of corn.

Kernel No.	Ear No. 1 Protein per cent.	Ear No. 2 Protein per cent.	Ear No. 3 Ash per cent.	Ear No. 4 Ash per cent.
1	12.46	7.45	1.50	1.10
2	12.54	7.54	1.57	1.08
3	12.44	7.69	1.61	1.09
4	12.50	7.47	1.56	1.10
5	12.30	7.74	1.67	1.07
6	12.49	8.70	1.69	1.09
7	12.50	8.46	1.71	1.07
8	12.14	8.69	1.64	1.10
9	12.14	8.86	1.64	1.21
10	12.71	8.10	1.74	1.11

The foregoing table, in which are shown the percentages of protein or of ash in ten different kernels from each of four different ears of corn, illustrates these two facts.

It will be observed that all of the kernels from any one ear contained about equal percentages of either protein or ash, but that different ears are markedly different in their composition.

The kernel of corn is not sufficient in quantity to permit a complete chemical analysis by any practical method, and of course the same kernel could not be used for analysis and also for seed, as can be done with the sugar beet; but the uniformity of the individual ear of corn makes it possible to determine approximately the composition of the grain by analyzing a sample consisting of a few rows of kernels, and the remainder of the kernels on the ear may then be planted if desired. The wide variation in composition between different ears is a very important factor in the work of selecting seed, as a starting point is thus furnished in each of the several lines of desired improvement, and, other things being equal, the greater this variation is, the more rapidly can a change be effected by breeding.

The general plan of the experiments to improve the composition of corn in any desired direction was to make analyses of samples from a large number of ears, select for seed those ears which were found to contain a high percentage of a desired constituent, plant in an isolated field (to avoid cross pollination from other corn, even of the same variety), and grow the crop under as good field conditions as possible. From the crop obtained a large number of ears are selected, and samples of each ear are analyzed, seed being taken, as before, from those ears which are found to be highest in the percentage of the constituent which it is desired to increase, and this process is repeated each year.

Plans were first made to carry on four separate experiments to change the chemical composition of corn:

1. To increase the protein content.
2. To decrease the protein content.
3. To increase the oil content.
4. To decrease the oil content.

As the carbohydrates are the complement of the sum of the

other constituents, it is of course manifest that if the percentage of protein and oil are increased the percentage of carbohydrates must decrease, and, contrariwise, if protein and oil are decreased the percentage of carbohydrates must increase.

The following tables summarize the most important results which have been secured from the four different series of experiments mentioned above. The percentages given are field averages of the respective fields or plots, which are about one-fourth acre each in size.

Breeding Corn to Increase Protein.

Field Averages of Per Cent. of Protein in Dry Corn.

Year.	In Seed.	In Crop.
1896	.....	10.92
1897	12.54	11.10
1898	12.49	11.05
1899	13.06	11.46
1900	13.74	12.32
1901	14.77	.....
Highest percentage produced in a single ear		16.11

Breeding Corn to Decrease Protein.

Field Averages of Per Cent. of Protein in Dry Corn.

Year.	In Seed.	In Crop.
1896	....	10.92
1897	9.03	10.55
1898	9.06	10.55
1899	8.45	9.86
1900	8.08	9.34
1901	7.58	.....
Lowest percentage produced in a single ear		6.66

Breeding Corn to Increase Oil.

Field Averages. of Per Cent. of Oil in Dry Corn.

Year.	In Seed.	In Crop.
1896	....	4.70
1897	5.33	4.73
1898	5.20	5.15
1899	6.15	5.64
1900	6.30	6.12
1901	6.77	....
Highest percentage produced in a single ear		7.40

Breeding Corn to Decrease Oil.

Field Averages. of Per Cent of Oil in Dry Corn.

Year.	In Seed.	In Crop.
1896	....	4.70
1897	4.04	4.06
1898	3.65	3.99
1899	3.47	3.82
1900	3.33	3.59
1901	2.93	....
Lowest percentage produced in a single ear		2.56

It will be observed that the average protein content of the corn grown on the high-protein plot has been increased from 10.92 per cent. to 12.32 per cent. by only four years' breeding. In other words, the protein content of corn has been increased 1.4 per cent. The importance of this can be better understood perhaps by considering that if it is increased .98 per cent. more it will be then as high as the average protein content of wheat, which is 13.3 per cent. The average protein content of oats is 13.2 per cent. The possibility of reaching this mark, or even of going above it, is evident from the fact that the average protein content of the

high-protein seed planted in 1901 was 14.77 per cent., while a single good ear of corn has been produced with a protein content of 16.11 per cent.—a positive encouragement, if not a definite promise, that corn may be so bred that it can be produced in unlimited quantities with a protein content far above the present average of wheat or oats.

A careful study of the above tables will reveal several other interesting facts and possibilities. For example, the average oil content of the corn which is being bred for more oil has been increased four-fifths of a pound per bushel ; or, according to the above quotation from the Glucose Sugar Refining Company, the value of this corn for factory use has been increased about four cents per bushel. On the other hand, the per cent. of oil has been reduced from 4.70 to 3.59 as the field average, while a single ear of corn has been produced with an oil content of only 2.56 per cent., or only about one-half per cent. higher than the average oil content of barley or rye.

CORN CULTIVATION TO CONSERVE MOISTURE

By Edmumd L. Worthen, Class of 1904.

The great drouth that prevailed over the corn belt of the United States last summer destroyed thousands of bushels of this golden cereal and caused an untold loss to the farmers of Illinois. Fields that under favorable conditions would yield from 50 to 100 bushels per acre, did not produce more than 25 to 50. Some were entirely destroyed, while others will not turn out more than 10 to 20 per cent. of what they should. No one can state the exact loss, but from the reports of numerous corn growers of this state it is estimated to be nearly 50 per cent., or, in other words, the yield is about one-half what it would have been under favorable conditions.

The majority of the farmers of this state are ignorant of the fact that a large part of this loss was unnecessary. Only the more progressive ones realize that much of the loss could have been averted by intelligent cultivation. It is true that under

such unfavorable conditions as prevailed last summer it was impossible for the farmer to raise a maximum crop of corn, but nevertheless he could have produced a far larger yield.

There is only one practical way of preventing or lessening these great losses caused by heat and drouth and that is by such systematic cultivation of the soil as will enable the plant to secure the greatest amount of the available moisture.

Before going further, let us look into the reasons for cultivation. The first one is to improve the physical condition of the soil, second, to improve the chemical condition, and third, to conserve moisture. Although each of these reasons is of great importance, it shall be the object of this paper to give special attention to the last—cultivation to conserve moisture.

First in order comes the preparation of the seed-bed, for in it we have the foundation of all the other operations which are to follow. The plow is the proper implement to use in the preparation of the seed-bed. The depth of plowing will depend largely upon the nature of the soil. Ordinarily about five inches is considered a sufficient depth to plow corn land, while in fact, plowing to a depth four inches is often as good. It is essential that we vary the depth of plowing from year to year in order to avoid the formation of a hardpan caused by repeated pressure of the base of the plow on the soil underneath it.

Of greater importance than the depth of plowing is the subsequent keeping of the previously overturned soil in a finely pulverized condition. The disc and cutaway harrow are excellent implements for pulverizing the under portions of the seed-bed, while the harrow, the planker, and the roller are of great value in pulverizing the upper portion. In this very careful preparation of the seed-bed we improve the physical condition of the soil by making it finer and looser, thereby presenting a greater feeding surface to the roots of the plants; and chemically, by admitting a larger quantity of air into the soil, which liberates a greater quantity of plant food.

Now as to the later cultivation, everyone knows that it is impossible to grow weeds and corn on the same ground at the same time, for the weeds will injure the corn by shading it and robbing it of moisture and fertility. We are therefore com-

pelled to follow some methods of cultivation that will destroy the weeds, and allow the corn to have the full benefit of the land. Although this is an important reason for cultivation, and some farmers think it the first and only one, a by far greater reason and the one which stands preëminently first in a dry season, is the prevention of the evaporation of moisture from the the soil and the preservation of as much of it as possible for the plant.

Secretary Wilson says in his report on the corn crop, that "six inches of rainfall is sufficient to make a corn crop if none were evaporated through the soil." "Such evaporation," he says, "cannot all be prevented, but such continuous cultivation as will maintain a dust mulch on the surface will do much towards it." Let us see how this dust mulch will conserve moisture. But first we must know where the moisture that our plants use comes from in a dry season like this. It is true that there is not enough of that which comes from the clouds. But fortunately nature has provided for such seasons, and way down below the surface, water has accumulated in large quantities. It is during the wet weather of winter and spring that this water works its way down through the soil and sub-soil to this great storehouse below. But how is this stored water to reach the roots of the plant? It is by the action of a force called capillary attraction which gradually draws the water back to the surface where it is rapidly lost by evaporation unless prevented by some artificial means, such as the dust mulch.

Now we have come to the point where we can intelligently discuss the advantages of an earth mulch. If the top of the soil be left packed, this water would come to the surface and evaporate before the plant could use much of it. But suppose we loosen the surface of the ground with a rake, harrow, or cultivator. This would break up the capillary action and prevent the water from reaching the surface. It would then be retained in the soil by the dust mulch where it could be used by the plant as needed. It is true that some of the moisture gets through this top layer of dust, or mulch, and is evaporated, but this quantity is slight, and on the whole this shallow cultivation to maintain a dust mulch is the most perfect as well as the most practical method known for the cultivation of the corn

plant. Now what is the best method of cultivating the soil of a corn field so that the largest amount of moisture may be secured and preserved in the soil for the use of the plant, the weeds kept down, and at the same time the roots of the corn not injured? I will attempt to answer this question by giving the methods which have proved the best at our experiment stations and on some of the largest farms of the state. In the first place we must not disturb the soil any deeper than necessary, for if we do, we will destroy many roots and thus weaken the plant. Two or three inches is deep enough and better than six, for by cultivating six inches deep we only expose more soil to become dried by the sun and air, and damage the corn by destroying its roots.

The first implement to use after the corn is planted is a harrow, or better a weeder, as it is not so likely to injure the young plants. The weeder should be run through the field as soon as the corn is up, or even before, so that no weeds will get started or a crust formed. In a week or two the corn becomes too large for the weeder, so from this time on we use the cultivator. The general opinion is that corn should be cultivated deep the first time. To a certain extent this is true, for by cultivating deep the weeds are more thoroughly destroyed and the roots of the corn not injured to any great extent, unless the cultivation be put off too long. So if we cultivate deep at all it must be when the plants are very young. Then, again, by cultivating deep the first time we improve the physical condition of the soil with but little injury to the plants. After the first cultivation the soil should not be disturbed below the top two or three inches.

From this time on through the summer a dust mulch should be preserved in our corn fields. As to the best implement with which to make this mulch, there is a diversity of opinion. Some claim that a small straight-toothed garden cultivator will do excellent work. I know a corn-raiser in Indiana who grows corn extensively for seed, who uses an old iron corn-planter wheel for the purpose of making a dust mulch. He hitches one horse to it and drags it repeatedly up and down between the rows of corn until he has produced a perfect mulch two or three inches deep. There are a number of shallow cultivators manufactured

now which have knives instead of shovels. On level ground where there are no weeds this class of cultivators proves very satisfactory. A common objection to them is that, even with the greatest precaution, much of the corn will be cut off by the ends of the knives, they being under the ground, and their distance from the plant cannot always be determined. Although used quite extensively in some localities this class of cultivators has not been generally adopted. The eight-shovel cultivator is today the most popular for shallow cultivation. This is because its shovels are large enough to kill the weeds thoroughly, and at the same time they pulverize the soil and leave it level. These shovels can be regulated to cultivate to any depth desired, but with the exception of the first cultivation, this should never be deeper than three inches. The use of the four-shovel cultivator should be discouraged. It may prove a little more satisfactory in keeping down weeds but a fine dust mulch cannot be produced with it, and it throws the soil up in ridges permitting much evaporation at the bottom of the furrows.

As to the frequency of cultivation I would say, cultivate after every rain that packs the top of the soil, and do it as soon as possible, for then there will be preserved any moisture that might have soaked through below the top two or three inches. If it does not rain within ten days or two weeks it is well to stir the soil anyway, not only to keep down weeds, but to break up the capillarity, because in that time the surface will commence to pack without rain. You may say, "I have been in the habit of cultivating my corn three times a year, and here you advise me to cultivate it after every rain. I might finish today and it rains tomorrow, then I would have all my work to do over again." Yes, if you want to raise the best crop it would be necessary.

Thus we see the reasons for this continued cultivation. Although it may be contrary to your common methods, the experience of our best corn raisers has proved its superiority. Therefore this method justifies a trial on every farm. Do not hesitate to try new methods, if only on a small scale at first, for it is through these experiments that our advancement in agriculture is made.

CORN STOVER.

By R. C. Lloyd, Class of 1903.

The term "corn stover" as here used refers to stalks, leaves, husks, and tassels of the Indian corn plant and does not include the ears. It is not the same as "corn fodder," which name is applied to the stalks of corn, either green or dry, from which the ears have not been removed.

Never before has there been so much corn harvested with the intention of using the stover as feed as there has been this fall throughout the corn belt. This is largely due to the past summer's drouth and the consequent small yield of hay and grain.

The farmers have become so accustomed to growing the corn plant for the grain that it yields, and to using the "roughage" as a sort of a straw, to be eaten or wasted as accident determines, that they have almost wholly overlooked its feeding value. The percentage of valuable constituents may seem small at first sight, but when the large tonnage is considered the value is higher than is usually supposed, and as this stover is a secondary product it is highly important that we give it due attention.

The cutting of the corn fodder may be done either by hand or by machinery. The corn binders now in use do very satisfactory work and much labor may be saved by them, as they not only cut the corn but bind it in bundles of a convenient size and carry them in rows for shocking. The time of cutting should be as early in the fall as possible without affecting the yield of the grain. The earlier the fodder is cut, the higher the feeding value; but if the corn is harvested before the grain is matured, the yield in grain will of course be affected.

The fodder should be placed in as large shocks as possible, so that little surface will be exposed to the weather, and there will be less waste in curing. The shocks should not be bound so tightly as to prevent them from drying out thoroughly, because mold may work much injury to the feeding value. The

loss in curing is much greater than is commonly supposed. The wind carries off exposed leaves and fine parts are lost by breaking off and falling to the ground during the process of harvesting and curing. The loss of dry matter through mechanical waste in curing may amount to ten per cent. For this reason care should be used in handling fodder during the process of harvesting. Dew and heavy rains also affect the quality of the fodder. The digestibility may be reduced four or five per cent., or more, if bad weather prevails during curing. To ascertain the amount of such losses, the Wisconsin station made investigations extending over four years, determining the dry matter and protein when the corn was first harvested and again after the shocks had been exposed to the weather for several months. The results of the four years' investigation showed a loss of 23.8 per cent. of protein—a loss of nearly one fourth of the dry matter and protein which the crop contained at harvest time by preserving the forage in the usual manner. The Colorado station has shown that even in the dry climate of Colorado heavy losses occur in shock corn. Even when all sources of loss are considered, the total loss cannot be accounted for, but probably much of it is occasioned by fermentation. In view of these facts, when calculating the value of a corn forage crop a deduction should be made from its value at harvest time, and for its reduced value at feeding time if the latter occurs some months after harvest. From this it may be seen that to diminish the loss and to keep the feeding value as high as possible shredding should follow as soon as fodder and grain have cured.

Although a great deal of fodder is husked by hand and the stover fed whole to live-stock, shredding is nevertheless coming into favor because it saves the labor of husking, while at the same time the stover is prepared so that the proportion readily eaten by cattle is materially increased. Stover after shredding may be handled much more satisfactorily. The waste, if any, makes excellent bedding. The value of shredded stover for feeding purposes varies according to the character of stover used, the animals to which it is fed, and the manner of feeding. The experiment stations, however, are not agreed as to the value of shredding or cutting. The Kansas station results show that

there was a waste of 31 per cent. of all cut fodder, and after three seasons the conclusions drawn were as follows: "The chief, almost only, value of cutting fodder is found in the fact that such chopped fodder can be placed in the manger and handled more conveniently than unchopped" It should be noted that the stover at the Kansas station was cut, and that shredded stover at the Wisconsin station gave quite contrary results. In the production of milk by using stover in the shredded form there was a saving of 24 per cent. of feed.

Corn stover is one of the best articles available for "roughage" in horse feeding. To idle horses and growing colts it may be fed to advantage. The stalks and husks will be partially uneaten, yet the leaves are relished when offered to horses under any conditions. Not only are corn leaves usually quite free from dust but they are palatable and full of nourishment. For stallions, brood mares, and growing colts corn stover of good quality will be found an economical substitute for timothy hay. When the tonnage of a field of corn fodder is compared with timothy hay from a like area, it is apparent that the forage of the corn plant should hold a prominent place with horsemen who seek economy and at the same time wish to supply a palatable and nutritious roughage. With work horses, however, one must use caution in feeding stover, for enough concentrated foods must be used so that the horses during the small time they have for eating may get the required amount of nourishment.

The results obtained at the Michigan station by feeding stover to lambs were very satisfactory. The lambs were divided into two lots of ten each: the first were fed stover, corn, and roots, and made an average weekly gain of 2.15 pounds per lamb; the second lot were fed, in place of stover, clover hay and bean straw and corn and roots, and made an average weekly gain of 2.30 pounds per lamb. Regarding this experiment Prof. Mumford says: "The principal objection to feeding stover to lambs is that when fed in the bundle in the rack the lambs waste a large percentage of the fodder. The only satisfactory method of feeding stover is in racks after it has been cut in a cutting box or silage machine. * * * The average daily ration of the fodder was 1.18 pounds for each of the ten lambs. Each

lamb in the lot receiving corn stalks as fodder rations gained an average of 2.15 pounds per week, or 30.2 pounds for the whole period. Such flattering results should make every sheep feeder value his corn stalks highly and induce him to take every possible precaution to properly preserve them."

Corn stover is a very good feed for dairy cows when fed with concentrated foods. At the Wisconsin station the value as compared with hay was determined in an experiment with dairy cows. The concentrated food consisted of five parts corn meal and seven parts of wheat bran, by weight. The hay ration consisted of ⅓ clover and ⅔ timothy hay. In comparing corn stover with mixed hay each was supplemented by 280 pounds of corn meal and 392 pounds of wheat bran. It was found that

2,374 lbs. stover returned 1,120.7 lbs. of milk, making.......57 lbs. of butter.
755 lbs. mixed hay returned 1,064 lbs. of milk, making.....56.1 lbs. of butter.

With clover hay it was found that

1,867 lbs. corn stover returned 1,079.3 lbs. of milk, making ..52.2 lbs. of butter.
643 lbs. clover hay returned 1,059 lbs. of milk, making ...54.5 lbs. of butter.

The returns being practically equal, we conclude that one ton of mixed clover and timothy hay is worth three tons of corn stover when fed under the above conditions.

AVERAGE COMPOSITION OF SOME COMMON AMERICAN FOOD-STUFFS.*

FOOD-STUFFS	Number of Analyses	Total fresh substance	Water	Composition per 100 parts of dry matter: Ash	Protein	Fat	Fiber	Carbohydrates.
Corn Stover (field-cured)	60	166.9	66.9	5.7	6.4	1.7	33.0	53.2
Clover Hay.............	38	118.1	18.1	7.3	14.5	3.9	29.1	45.2
Timothy Hay............	68	115.2	15.2	5.1	6.8	2.9	33.5	51.7
Oat Straw..............	12	110.1	10.1	5.6	4.4	2.5	40.7	46.8
Corn (grain)	86	111.9	11.9	1.7	11.5	5.6	2.6	78.6
Oats (grain)	30	112.4	12.4	3.4	13.2	5.6	10.8	67.0

The foregoing table shows the average composition of sixty analyses of stover, along with clover, timothy hay, and oat straw, so that a comparison may be made.

*From Bull. Ill. Agr. Exper. Station, No. 43.

It will be seen from the table that the water content of stover is high, and for this reason in feeding weighed amounts an allowance should be made for the fact. Of protein—the most valuable of all food constituents—stover contains 2 per cent. more than oat straw, only .4 per cent. less than timothy hay, and 8.1 per cent. less than clover hay. In fat it is the lowest, while in carbohydrates it is the highest.

The chemical analysis does not give the true feeding value of the constituents, and this can only be ascertained by referring to a table showing the digestibility of the substances. The following one does not give the digestibility of the foods with the same kind of live stock, and for this reason it is unsatisfactory, yet some comparison may be made by means of it.

AMOUNT OF DIGESTIBLE SUBSTANCES IN SOME COMMON FOOD-STUFFS*

	Pounds required for 100 lbs. of dry matter.	Pounds of digestible nutrients from 100 pounds of dry matter.					
		Dry matter	Ash	Protein	Fat	Fiber	Carbohydrates.
With Cattle							
Corn Stover......	167.0	62	2.6	3.3	.9	22.1	34.0
With Sheep.							
Timothy Hay	115.2	59	1.9	3.3	1.9	18.8	33.1
Clover Hay	118.1	53	2.7	7.5	1.9	13.7	27.1
With Swine.							
Corn (shelled)....	111.9	83		7.9	2.6	1.0	70.0

This table shows that a larger percentage of the protein of corn stover is available for digestion than the protein of either clover or timothy hay. Stover contains nearly as much digestible protein as does clover hay and as much protein as timothy hay. When compared as to carbohydrates, stover contains 6.9 per cent. more than clover hay, and .9 more than timothy hay.

The digestible nutrients in one acre of stover—the average taken from four stations—was protein, 83 lbs.; carbohydrates, 1493 lbs ; ether extract (oil) 22 lbs.; total 1578 lbs., or 37 per cent. of the whole digestible nutrients of a crop of corn grown for grain.

*From Bull. Ill. Agr. Exper. Station, No. 43.

The time has passed in American agriculture when corn stover, containing as it does 37 per. cent. of the digestible nutrients of the crop, can profitably be allowed to weather and waste in the fields.

HISTORY OF INDIAN CORN.

By A. D. Shamel, B. S., Instructor in Farm Crops.

It is probable that Indian corn originated in central Mexico. From the fact that three genera of close relationship—*Zea*, *Tripsacum*, and *Euchlœna*—exist in this region, it is likely from the principles of geographical botany that they originated in this section of Mexico. In the fields of corn now grown in the great corn belt, frequent reversions to the type now growing in Mexico are found. For instance, some plants grow an extraordinary number of suckers, which was the principal method of propagation of the wild plant in Mexico The civilization of the Mayas, the oldest of any race on the American Continent, developed in the plateaus of Mexico. These people are responsible for the development and improvement of the seed-bearing tendency in the corn plant. They cultivated it for food, and it is likely that they found it growing wild in this region. It is further true that we find a greater number of varieties of maize growing wild in Mexico than in any other place. This indicates that it has been grown longer there than in any other country, and has consequently had more time for variations to be developed. It is very probable that the agricultural methods of the tribes of Indians in the North and South American Continents were largely

borrowed from the Mayas living in South Central Mexico. From these facts we believe that Indian corn was carried north and south by barter and trade, and has become one of the principal objects of cultivation in both continents.

The first explorers of America found maize growing in great abundance. For instance, it is a matter of history[1] that Cartier in sailing up the St. Lawrence river in 1535 found the region of Montreal one great corn field. The Puritans were sustained through the long bleak winters of inhospitable New England by Indian corn grown by the Indian tribes in that region. In 1685 the French army invading the region of Ontario county, New York, destroyed great areas devoted to the growing of corn. It is stated[2] that in one crib alone 1,200,000 bnshels were found and destroyed. In the settlement of Jamestown, about 1607, we have in history the romantic story of Pocahontas supplying the settlers with corn.

Records from the exploring voyages of the early missionaries show that as early as 1562 corn was found abundantly growing in Florida, Arkansas, Illinois, and many of the western and southern states. In fact it seems to be a well-authenticated fact that at the time of the discovery of America Indian corn was found extensively growing in all regions visited by the early explorers. Its cultivation was very crude, and the plant was comparatively undeveloped by any human selection. In a vague way it is probable that the Indians selected those ears for seed which were the easiest to prepare for food ; that is, selected the ears which contained the greatest number of kernels and the least amount of husk about the kernels. During this time a natural selection was weeding out the undesirable types. The frosts of the early winter destroyed all the seed which did not mature in the short season of the northern land. Ears that were borne on weak stalks, falling over on the ground in the wind or snow, were destroyed. Ears that did not bear enough general husk to protect the kernels, were attacked by wild animals and birds. The kernels which were weakened by unfavorable

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1. Harshberger.—"Maize," p. 130.
2. "Aboriginal Monuments of New York," pp. 63-66.

conditions or succumbed to some disease were not likely to develop under the Indians' careless method of planting. Such types were quickly destroyed and lost. The entire tendency was to produce a hardy plant. This led to the development of the flint corns which are grown today in an improved state in New England and many northern countries.

From the evidence of Indian mounds and houses it is likely that Indian corn was brought north from Mexico directly into what is now Arizona and New Mexico. In some of the cave-dwellers' homes in Arizona and New Mexico Indian corn stalks are found embedded in clay, serving as rafters to these rude houses. These rafters have been embedded in this clay, and in the very dry climate of this region have remained preserved to the present day. From this territory the Indians, by exchange and barter, carried Indian corn to the region which now constitutes the states of Kansas and Nebraska. From here corn was carried across the Mississippi to Illinois, Indiana, Ohio, and from these states by easy stages to the region of New England. In the mounds of Ohio and surrounding states corn has been found among the numerous articles buried with the Indian chiefs. The museum of the University of Pennsylvania and the Field Columbian Museum contain very interesting collections of articles buried with Indians in the mounds of these ancient tribes. Among these articles, mostly implements of warfare, are the remains of various kinds of what must have been stores of food to supply the spirit on its long journey to the happy hunting grounds. In one instance there are charred ears of corn. This proves that even at this early day corn was an article of food among these tribes. Since the settlement of America by white people, Indian corn has undergone a remarkable development. This advancement and improvement has been very slow until the development of the fertile lands of the Mississippi Valley. The New England settlers, emigrating to the west, carried corn with them. It was found that in the rich fields of the central west corn developed in a remarkable manner. The stalks increased in size, and the ear developed a depth of kernel and size unknown in the eastern states. As this plant became of more importance to the welfare of the early settlers more attention was given to its culture.

From this point onward the development has been very rapid. Certain types were found to be particularly valuable for certain purposes. These types have been selected with considerable care by certain pioneers, and breeds of corn are the result. These breeds have been improved beyond the ideas of their original growers, so that we may now safely say that varieties of corn are firmly established,

Among these pioneers in corn breeding the name of J. S. Leaming, of Wilmington, Ohio, stands preëminent. Mr. Leaming began improving a certain type of yellow corn common in southern Ohio as early as 1825. The yellow corn was a small-eared, yellow dent variety. It was likely a flint type, which under western conditions of soil and climate developed into the dent type. This change was quickly followed by an increase in the number of rows of kernels and a deeper kernel. Mr. Leaming selected those ears for seed which were particularly well filled out over the tip and butt. The increase in the number of rows of kernels took place at the butt of the ear, so that in the type grown about 1850 the ear tapered very decidedly from butt to tip. This taper was due to the greater number of rows at the butt of the ear. This breed of corn is still grown by Mr. Leaming's son, J. S. Leaming, Jr., near Wilmington, and is of nearly the same type as that grown by the originator.

This Leaming type was brought west to Illinois and introduced to western farmers by Mr. E. E. Chester of Champaign county, Illinois. Mr. Chester, an extensive cattle feeder coming from Ohio, quickly recognized the value of this type of corn for Illinois conditions. Upon his rich farm this corn developed extraordinary yields. From the small tapering-eared type it developed under ideal conditions into a large cylindrical-eared type. The number of rows of kernels on the cob was further increased, the tip was filled out with its full complement of rows, and the depth of the kernel increased. In the early nineties Mr. J. H. Coolidge, of Knox county, procured seed of this type from Mr. Chester, and under his system of selection a different type was produced. This type is peculiarly suited to the north-central sections of the state, and by long and very careful selection has been further improved over the original type. Other strains

have been produced in recent years, but none have as yet had time to sufficiently develop distinct and peculiar characteristics so that they may be called varieties.

Another pioneer better known to the corn growers of the corn belt as a corn breeder, is the late Mr. James Riley, of Thorntown, Indiana. Mr. Riley began his selection of corn from the ordinary white corn in his section of the corn belt. By careful selection of the ears used for seed he produced a type which he called Boone County White, in honor of his home county. This is a large white corn with a large number of rows of kernels and particularly broad and deep kernels. By reason of its careful development it soon became very popular with many corn growers of the adjoining states. Several well known corn breeders have taken this variety in hand since the death of Mr. Riley and are further improving it. Mr. Riley also originated Riley's Favorite, a yellow variety. This is a variety originated from a cross between a small early, and a large late, corn. The type has not as yet become well fixed. It has been bred for several years by Mr. F. A. Warner, of Sibley, Illinois, who is accomplishing a great improvement over the original type.

Most other varieties of corn now grown by established breeders are the results of selection from these two great types of corn. Climatic and soil conditions combined with selection have effected wonderful changes. These changes in type are a promise of what may be accomplished in the near future with this great cereal crop.

Indian corn was carried to Europe by the early explorers of America. Very likely it was first taken to Spain. The celebrated presentation of ears of corn to the king and queen of Spain by Christopher Columbus shows us what degree of importance was attached to this crop by these far-sighted men. Owing to the beauty and evident utility of corn, attempts at culture were generally made in European countries. Spanish and French land owners eagerly began its cultivation with the idea of producing a more profitable crop than they then possessed. From France corn was carried to Germany, Italy, Austria, and Russia by barter and trade. Some feeble attempt at culture in England followed the return of the English explorers

from the New World, but owing to the unfavorable climate little success attended these efforts. On the continent of Europe more success attended its culture, so far as climate was concerned. However, the farmer of those countries, the European peasant, was not accustomed to the culture of such a crop, and it did not fit into any system of rotation there in use on the small farms. As a consequence, its development in Europe has not been great, and its production there does not figure at all in the market of the world. It is not likely that it will ever fit into any scheme of agriculture in these crowded countries, and therefore will be of little use to their people.

In South America considerable attention is given to the cultivation of corn. The greatest advance has been made in Argentina, where improved machinery has been largely introduced. The fertile soils and favorable climate of some sections of this country make it probable that, upon the development of agriculture, Indian corn will be extensively grown in all sections adapted to the crop. The corn grown there for the most part is the smooth-grained, flint-eared type, producing a small proportion of corn to cob. Such corn is not so profitable as a deeper-grained, dent type. Other South American countries may be developed in time, so that corn will form an important part of their agriculture. Peru, Brazil, and other states now grow a small amount of corn. There is room for the bringing into cultivation of great territories now undeveloped. When the time comes that these countries take up the development of agriculture and the improvement of their lands a vast territory may be opened up for the growing of corn.

In Asia there seems little place for corn in the system of agriculture now carried on. The intensive crops grown by the small farmers of the Asiatic countries are grown for human food, and the comparatively small amount of animal food required is produced in the form of millets, sorghums, and some leguminous crops, as the soy-bean and cow-pea.

The one continent yet to be opened up, which may some time be devoted to corn, is Africa. It is known that great territories there are adapted to corn culture. It may be that in the course of time Indian corn may be grown extensively in

Africa. Some prominent agriculturists confidently predict that upon the development and settling up of our corn belt, when the farms become small and intensive cultivation is the rule, that then this great African corn belt may be taken advantage of and the supply be furnished in part from this source.

At present maize is distinctively an American crop. In all probability named after the ancient American Indian people, the Mayas, supporting the brave explorers of North America in the hardships of their first winters, nourishing the civilization of the greatest people in the world, it begets our awe and admiration. By reason of its inherent capacity for variation its improvement is a matter of comparatively easy accomplishment. Owing to its value as a food, both for animals and men, its breeding is a matter of immense importance. The developments of the future cannot be even hinted at. Suffice it to say that we believe that no man can predict the uses to which it may be put, or the improvement in it that may take place in the next hundred years.

IMPROVEMENT OF FARM CROPS.

By Coates P. Bull, B. S., Instructor in Plant Breeding.

Never before in the history of agriculture has there been such an interest shown in the improvements of both plants and animals as is manifest at the present time. Until recent years these two classes of life were supposed to be widely different, but it now appears that these differences are less real than apparent and the work of improvement is conducted along similar lines by similar methods. The laws which Colling Brothers followed in their great work of improving and developing the Shorthorn cattle are identical with those followed by de Vilmorin in the improvement of the sugar beet and in developing the carrot from the wild species, and the same laws guided Buckman in the development and improvement of the parsnip.

Darwin, in discussing the theory of evolution, outlined, so to speak, the work which in later years has been carried out by Bakewell, de Vilmorin, Dr. Nilsson, and Garton of the Old World, and Burbank, Bailey, and many others of this country.

For the most part plant breeding has been carried on along lines most fascinating to the scientist. Much has been accomplished in horticulture and with flowers, but the more staple crops have received very little notice until within the past few years. It is now time to take up this great work with a will, and profit by the experience of our horticultural and floral friends. There is a large uncultivated and exceedingly fertile field for the operation of breeders who shall devote their energies to the improvement of farm crops. We are greatly indebted to the pioneers in the work of selective breeding, for by their examples and methods the work of improving farm crops has been immensely facilitated.

The effect of man upon the distribution and improvement of our economic plants is far from the limit of possibility. Much,

however, has already been done both in improvement of well known varieties and in the introduction and distribution of varieties peculiarly adapted to certain districts. The breeder works with variations as they exist naturally within the different plants, and sometimes produces a much wider limit of variation by hybridization. He deals in immense numbers wherever his land and capital will permit, thus widening the limit of variation and increasing the chances of getting that plant, which when selected and established, will produce the ideal which he has in mind. It must be thoroughly understood that it is only one plant in many thousands which varies from the type in the desired direction; but with large numbers, careful study of variations, and judicious selection results are very certain.

The Garton Brothers, of England, who are doing extensive work on the improvement of cereals and forage plants, pay the closest attention to variation, often inducing special variation and then selecting for increased yield, uniform type, and new and attractive varieties. These ideals or standards must be such as will be recognized by the dealer and the consumer. Plants are so susceptible to variation under artificial conditions of culture that one may not be surprised at marvelous results in years to come.

Within the last five years material progress has been made in this state in modifying the chemical composition of corn. The seeds were selected by analysis for high percentage and low percentage of fat. The resultant crops were analyzed and selected for a few years, and it was found that a variation in fat of from two to two and one-half per cent. was procured. It is further noted that it makes no perceptible difference in this variation when the corn is planted under various conditions, even though the yield be greater or less than normal.

Soil and climatic conditions exert much influence upon plant growth. Some climates are moist, some dry, some are hot, others cold, and with various combinations of these conditions we get ever changing characters of plant growth. It is evident, then, that the breeder in his selection must have clearly in mind the conditions under which the plants are to grow. Then it becomes necessary to furnish plants suited to the various local-

ities. We have plants which are especially adapted, through generations of growth, to a humid atmosphere and a certain type of soil. These plants, if taken to semi-arid districts, do not grow successfully on account of their inability to readily adapt themselves to the changed conditions. Again, we have plants which are indigenous to our semi-arid districts and are comparatively resistant to heat and drouth. These plants when grown under other conditions do not compete with those plants normal to those conditions. As an example of a plant adapted to semi-arid districts we have kaffir corn ; but this plant when grown in localities favorable for maize is not considered a success. Maize, however, is not a competitor with kaffir corn in the semi-arid country. As an example of the introduction of plants suitable for peculiar conditions we have the date palm introduced from North Africa into Arizona, and the Turkish red wheat introduced into the winter wheat section of the middle west.

The exchange of seed grain is often thought to be of benefit to the farmer ; but it depends largely upon how radical the change is, on the quality of the grain, and upon the length of time the farmer is willing to try the new seed. If the seed is of good stock and has yielded, on an average of several years' trials, more than that commonly grown, other things being equal, its introduction may prove to be profitable. The farmer must, however, be his own judge and look at the subject from all sides before he decides whether or not it will be a paying investment.

The work of the plant breeder is not alone the originating of new varieties through the selection of so-called sports or by hybridization, but it includes the introduction of foreign varieties and species and adapting them to our conditions. It also includes the improvement of old and well tried varieties in common use; and it is this latter work which properly demands the greater part of the breeder's attention. It is only occasionally that a new variety or an introduced stock will exceed in yield those stocks which have been tried and grown for years. But when once a stock is found superior to the common ones and the superior qualities are fairly well established there is little danger of

"running down"—if the average amount of care is taken in the selection of seed—and this care is within the reach of every farmer who will turn a fanning-mill.

With the new and improved class of produce comes the question of a market demand for such goods. There need be at present no attempt made toward establishing such a one, for it cannot come by a sudden transition. The farmers must grow the improved stock before they can demand a market for such produce. Certain standards of value must be recognized to be not only present but permanent. Not only the dealers but the consumers must be impressed with the fact that such standards exist before a market demand can be made, and when such values and standards exist the demand will be with the crops as it was with dairy produce after the invention of the Babcock test. The market will be revolutionized, much to the benefit of the farmer, produce will be sold entirely upon its intrinsic value, and the farmer will reap that which he sows. If he chooses to deal in improved stocks he will reap according to the quality of the improvement. With farm crops, as with live stock, it costs no more to raise well-bred stock than it does to raise "scrub" stock, but the remuneration is vastly more. There has been created in this state within the past few years a demand for an improved grade of corn. The Glucose & Refining Co. offers, as an incentive for better bred corn, five cents per bushel more than market price for every per cent. of oil content above the common average of the state. The company making this offer uses annually about 18,000,000 bushels of corn. If by selective breeding this quantity of corn could be made to bring five cents per bushel above market price, it would mean much to the farming population ; or if we add five cents per bushel to the average price received for the corn of the United States, it can readily be seen what an addition this would be to the nation's wealth.

Plant improvement is accomplished in several ways. The simplest of these is in the selection of good sound seed. By judiciously selecting the seed the yield may often be increased a bushel or more per acre, and even greater increase may be obtained by selecting prominent types and increasing these to

field quantities. The increased yield is however only a small part (though a prominent one) of the ends sought in breeding; the intrinsic qualities, both chemical and physical, may be improved with marked profit. An increased nitrogen content of our forage and fodder plants would mean much to the feeder.

The importation of a more hardy class of plants and their adaptation to certain districts may properly be called breeding, and will add much to the number of varieties from which a farmer can select to suit his particular conditions. It will greatly benefit and facilitate the system of farming and crop rotation so much needed in all our agricultural communities ; it will furnish varieties suitable to our semi-arid districts and thus increase the farming capacity of our country ; and it will bring new industries and commodities to our states and furnish another recourse for the skilled and unskilled labor population.

Much is often accomplished by watching for chance characters and sports. In the animal world some of the best steps have been made along this line of breeding. In the plant kingdom we are indebted to sports for many variegated floral curiosities, but on the whole the time is better spent in breeding along more constant lines. The sportive plant is indeed rare which is an economic improvement over the variety with which it is identified. Much work therefore comes to naught, except for the knowledge of methods of breeding derived, by adhering to the breeding of sports. A more stable and in the end more satisfactory method is to study closely the individual variations and select for mother plants only those which give some promise of improved economic value.

By hybridizing, many of the desired qualities may be united to produce a wider variation from which selections can be made as foundations for varieties of desirable quality. The shattering, for instance, of loosely chaffed grain, as blue-stem wheat, may be materially remedied by the use of plants like emmer with closely adhering glumes. The resistance to drouth and rust may also be increased by hybridizing with varieties considered less susceptible.

The expenditure of thousands of dollars is justified in agricultural communities for the promotion of plant breeding and

investigation. The discovery and improvement of the Wealthy Apple by Mr. Peter Gideon, of Minnesota, is enough to justify such a statement. This one man through years of trial and labor has added millions of dollars not only to Minnesota, but to the entire Northwest. Babcock has added immensely larger sums to the whole world through his experimental investigation.

Burbank is continually adding new and improved horticultural products to this country, and Professor Hays is doing much in the Northwest in originating new and improved varieties of grain. In this state likewise large sums of money can be added to the income of the farming population by the expenditure of a comparatively small amount. The wheat crop, for instance, which has been on the decline in Illinois for the past fifteen or twenty years, can be made much more remunerative by paying attention to breeding. The additional yield of a single bushel to the average (which is about 16 bushels per acre) would, according to the census of 1890, which gave the total number of acres sown as 2,310,000, add $1,386,000 to the wealth of the state. With other crops, as with wheat, there may be a a greater or less amount added to the annual income, according to the total valuation of the crop.

As this work of crop improvement is of such vital importance to the whole commonwealth it should be liberally supported by state appropriation. The subject is a broad and serious one and should receive the careful thought and attention of the best minds in the country. Let us have coöperation in this great field and let us work for the good of the whole.

A STUDY OF OATS AND THEIR GROWTH.

By DeWitt C. Wing, Class of 1904.

The State of Illinois produced in 1900, 164,909,129 bushels of oats, worth $33,016,444, and hence ranks first in the production of that valuable crop. The area devoted to oats consisted of 4,065,-202 acres, which gave an average yield of 40 bushels. Of the 102 counties in the state, Livingston county was the largest oat producer for 1900, with Champaign coming second and Will third, their respective yields being 8,596,984, 6,596,616, and 5,139,685 bushels. The first and third are in the northern division of the state and the second in the central. The smallest yield recorded is that of Alexander county, in the southern division, which produced 27,570 bushels, and according to the figures of the State Board of Agriculture lost $276 on the crop.

The feeding value of oats and their importance in rotation with other farm crops, together with the fact that according to statistics the crop is annually produced at a great loss to the state, make the study of oat production a very important one.

The principal causes which have operated to decrease the yield and quality of oats, and thus to lessen the profits in growing them, may be stated in five words: poor seed, poor seed-bed.

Seed oats are in many instances impure, small, and of weak vitality. If a white variety, a considerable per cent. of black oats may generally be found in the seed bin of the average farmer. Aside from this mixing of varieties the seed often contains weed seeds, such as yellow mustard and sour dock, and not less frequently trash which interferes with the proper distribution of the seed. Some of the seed is small because prematurely harvested; some is small as the result of weakness in the parent plant; and still another lot is small because of a degeneration of the variety of oats. The vitality of the seed may be weak for

three reasons: 1. Premature harvesting of the crop. 2. Lack of proper protection during the winter. 3. Lack of vitality resulting from inferior seed persistently sown under unfavorable conditions in a given locality.

The seed-bed may be poor both in respect to the fertility of the land and the preparation given it. In a large majority of cases the latter is at fault. The deep, black prairie soils in the oat belt of Illinois are rich enough to produce successive crops of oats for many years without evidences of serious impoverishment. It may be added, however, that corn and oats have so long been grown alternately on some soils in the northern division of Illinois that decreasing yields are directly due to the gradual diminution of available plant food. As the area thus affected constitutes only a very small part of the 4,000,000 acres sown to oats in 1900, it were time better spent to consider those imperfections of the seed-bed which are due to a lack of proper preparation.

Perhaps 90 per cent., or more, of the farmers who grow the bulk of the Illinois oat crop prepare the seed bed by disking once after the seed is sown, sometimes giving another disking, followed in some cases by a harrowing. As the ground is usually hard in the spring, owing to heavy rains, and the discs commonly used are light, it is impossible to secure a perfect condition of the soil in the manner indicated. It is particularly difficult to put the seed-bed in proper condition in fields poorly cultivated the previous season. The corn stalks prevent the discs from cutting up the ground to a uniform depth of more than two inches, and the result is that the seed is not well covered.

When seeding is finished an examination of the field prepared as described will show that a large per cent. of the oats are uncovered, and those that are covered have not enough fine loose dirt over and under them. Many of the uncovered kernels never germinate, and the plants of those that do germinate are not able to compete with the stronger plants from the covered seed for plant food and moisture. The struggle for supremacy is an energetic one, and the surviving plants are injured in proportion to the severity of the competition to which they are subjected.

Presence of smut in oats may be regarded as a more or less potent factor in diminishing the yield of grain. When from 10 to 20 per cent. of the heads are smutted the loss amounts to no small item in a field of 80 acres, and in this connection it will be recalled that in 1900 the average per cent. of smut for the state was 14, as determined by careful tests made in different parts of the state by a large number of farmers under direction of the College of Agriculture. As a result, the farmers sustained a loss of $930,000. Since the discovery of several effective and inexpensive methods of ridding seed oats of smut spores, there is no longer any excuse for the appearance of smut in the oat fields of Illinois.

Oats have been grown and handled so recklessly and carelessly on the average farm that it is difficult, if not impossible, to secure pure seed of good quality from farmers. They say "oats are oats." Yes, and corn used to be corn, too. It is high time that oat growers were beginning to breed up this great cereal just as the corn growers are improving maize. It is time for a clear distinction to be made between good and inferior oats, whether they are to be fed or sown as seed.

This suggestive and not very inviting inscription appeared on the bulletin board of a city grocer : "Good eggs, 25 cents a dozen ; eggs, 10 cents a dozen." There should be sufficient difference between first-class, sound, well-ripened, clean, pure-bred oats and the grade of oats commonly sold to warrant this announcement on the seed dealer's bulletin board : "Good oats, $1 per bushel ; oats, 15 cents per bushel." To raise the entire crop on each farm to the first quality and to adopt for the distinct varieties names by which they shall be known wherever grown or sold, are prime objects among the many important questions connected with the production and improvement of oats which furnish ample justification for the establishment of an Illinois Oat Growers' Association.

I would not be understood as intimating that there is a dearth of names for oats. Of the three score, or more, of names by which seed oats are sold perhaps fifty or more of them could be dropped without a single variety suffering extinction. We need a severe revision of our present catalogue of variety names.

First in importance in improving any crop is the seed. That strong thrifty plants should come from small weak seeds is as much to be expected as the production of figs by gooseberry bushes. Whether a farmer should buy or select from his own granary seed oats for next spring's use is a matter which may be considered from two points of view :

1. If he buys seed oats he is likely to get a quality perhaps not better than that which he already possesses, unless he patronizes a thoroughly reliable seedsman. If seed is purchased from a seedsman he should guarantee its purity and vitality. Its freedom from noxious weed seeds also should be sworn to. The seed should be unmixed. If a white variety, no black or half-black kernels should be in the lot; if a black variety, no white or half-white kernels should be found in it. The kernels should be uniform in size and free from must; and they should test at least 95 per cent. vitality and be free from smut, though it will be well where the quantity is small to treat them with hot water in order to make sure of their freedom from the spores. Information as to where the variety originated, when and by whom, and a full statement regarding the conditions under which the seed stock was grown, when and where, and a catalogue of its chief characteristics should accompany the purchase. The seedsman owes this valuable service to his patrons, who should insist upon its faithful performance.

2. In case it is desired to select seed from the threshed oats on hand at sowing time the following points should be borne in mind: (a) stage of maturity of crop when harvested; (b) kind of protection given seed during the winter ; (c) purity of seed. If the crop was harvested prematurely the seed will be weak in vitality, and if stored during the winter in a damp place it is probable that this also will lessen its vitality. If the variety has been grown on the same farm or in the same community for a number of years it is likely to be considerably mixed. Having found its vitality satisfactory by applying the usual test, the seed should be given two fannings in a good fanning-mill. Weed seeds, trash, and small and light kernels will be fanned out and the largest and best kernels retained. If there was smut in the crop the seed should be treated for five

minutes in water heated to 138° F., and sown the same day. It is not advisable, however, to treat large quantities—merely enough to produce ample seed for the next year.

It is safest to use northern-grown seed in any case because of its early-maturing tendencies, and it has been found an excellent plan to seed half the allotted area to early oats and half to late oats, of the same color. Harvesting the crop is thus made easier, and it may be done without liability of having to cut some of the crop unripe and some too ripe. On finishing the early oats the late crop will be ready for cutting. The usual rush may thus be avoided and the oats harvested in fine condition. Where white and black oats are grown on the same farm they are almost sure to become mixed, and their value as seed is thereby lessened, since the price for pure oats of either white or black varieties cannot be secured on the market. Mixed white varieties are always preferable to white oats mixed with black oats, or vice versa.

The results of experiments conducted the past season on the Sibley estate, in Ford county (north-central Illinois), by the writer and his associate, Mr. John McCarty, justify a favorable mention of the Early Champion and Twentieth Century—very early and medium early white oats, good yielders, and stiff, upright growers—and Black Tartarian, a late black oat, very prolific, maturing July 25.

To summarize what has been said about seed: Let us sow pure seed, black or white, large, sound, and clean, free from must, trash, and weed seeds. Its vitality should be unimpaired; if bought, its history should be known; and early and late varieties of the same color should be sowed.

Having good seed, proper preparation of the seed-bed is the second step looking to the improvement of oats. Upon this work will largely depend the success of the attempt at oat improvement.

The prevailing practice is to follow corn with oats. The stalks are in some cases harrowed or dragged down before the land is disked, but the rule is to sow the seed right among the standing stalks, then disk and harrow.

Not so much depends upon how much work is done, as upon

how it is done. We are to prepare a field of fifty acres for oats. It is in a square. The corn stalks are partially standing, partially broken down. There are some weeds and grass in the field, though the corn was fairly well cultivated. It was laid by north and south, the rows being slightly ridged. The ground is hard but ready to work.

1. Run a sharp, heavy disc east and west, this being at right angles to the last cultivation of the corn. Let the disc lap over two or three feet on the land already disked. The reason for disking crosswise of the last cultivation of the corn is that the ridges are chopped up better than if the disking were parallel with them.

2. After disking as described, harrow the field north and south with an ordinary steel-frame tooth-harrow. This operation will partially even the surface and drag the corn stalks in the direction harrowed. Follow with the same disc used at first, having it adjusted to run deep, but not to form ridges. This disking should be parallel with the harrowing preceding it. The corn stalks being harrowed straight with the disking do not interfere with the proper action of the discs or cutters between which they pass.

If the work thus far has been well done the surface should be thoroughly chopped up to a uniform depth of at least three inches, and in first-class condition to be seeded, the last disking havin gmade little furrows into which the seed may fall.

Seed may be sown with an end-gate seeder or with any of the modern seeders in common use. Sow at the rate of 2½ bushels per acre, half of the field to an early oat and half to a late variety of the same color. Cover with an Acme harrow or other implement of similar construction, running at right angles to the last disking. This should complete the work in very satisfactory shape, covering the seed well and smoothing the surface. It is essential to a good stand to cover the seed as uniformly as possible to a depth of at least two inches. If the ground should be tolerably dry and no rains should follow seeding for a week or ten days, uncovered or partially covered kernels will germinate too late to make plants sufficiently vigorous to compete with those from the covered seed.

An experiment to determine the effect of plowing land in the spring for oats was conducted at Sibley the past season. An adjoining plat was disked. The former yielded at the rate of 40 bushels per acre ; the latter, 37 bushels. It will be seen, therefore, that the difference in yield does not compensate for the extra labor involved.

Early and late oats, black and white, tested under identical conditions did not vary materially in respect to yield. The belief is fully jusfified that if sown at the same time, as they invariably should be, early oats are no larger producers than late varieties.

Oats for seed should be harvested when fully mature ; if for feed they may be cut earlier. As soon as in good threshing condition they should be threshed from the shock. A delay at this stage may mean loss because of damage by rains. If the crop is for seed the threshing-machine should be run empty until thoroughly free from any oats that might have been carried in the separator from other farms. Every effort should be exerted to keep the seed unmixed.

More than 300 bushels of seed oats were treated in hot water for smut last spring at Sibley and the resulting crop was not infested with the parasites. The average temperature was 138° F.; time, five minutes. Untreated seed produced from 3 to 13 per cent. of smutted plants.

Experiments with dry heat for killing smut showed 140° F. to be the most effective temperature at which to treat infested seed. Seed treated at 180° failed to germinate ; treated at 135°, smut spores were not all killed. Dry heat undoubtedly will kill smut if it can be uniformly applied and accurately controlled.

To "breed up" a variety of oats rapidly the following method has been suggested by Mr. F. A. Warner, Manager of the Sibley Estate : "Run a peck of the seed through a fanning-mill two or three times, adjusting the sieves as required ; spread the seed thinly on a smooth surface and select by hand a quart of the largest and best kernels in the lot ; treat them for smut, and the same day sow by hand in rows eight inches apart and one kernel every four inches in the rows ; cover two inches

deep. Use a good piece of land and make the seed-bed perfect. When mature select the largest and best heads and thresh them out in a sack with a flail. Run the seed through a fanning-mill twice, and again spread out for selection as before. This plan eventually will evolve a large, strong, prolific oat"

Forty bushels of oats per acre do not yield a profit. To make the production of oats profitable there must be larger yields of a better quality—60 to 80 bushels per acre. With proper attention given to the seed sown and the preparation of the seed-bed paying yields of this great crop should become the rule rather than the exception.

AN EXPERIMENT IN MUTTON PRODUCTION.

By J. H. Burdick, B. S., Class of 1901.

This experiment in the fattening of lambs was conducted at the University of Illinois by the writer and Mr. C. H. Fellingham, as a graduation thesis investigation in animal husbandry.

The lambs used in this experiment were purchased from Clay, Robinson & Co., of Chicago, on February 1, being selected from a lot of Michigan grade Shropshires. For a few days after their arrival at the University the lambs were kept in a paddock and fed only clover hay. After they were placed in the pens they were fed on oats and clover hay for about two weeks. They were then weighed and divided into four lots of four each,

the lots being made as nearly uniform as possible. The change to the different rations was then gradually made. On February 28 the lambs were weighed and the experiment started.

In order to make this work of the greatest value to Illinois feeders the grains used in this experiment were those grown in the usual crop rotation practiced in Illinois. Gluten meal was also used in this experiment for purposes of comparison with other concentrates, the object being to determine whether the gain resulting from its use would warrant its purchase.

The grain rations of the different lots were as follows: Lot 1, shelled corn; Lot 2, shelled corn and gluten meal, two to one by weight; Lot 3, shelled corn and oats, equal parts by weight; Lot 4, whole oats.

The gains put on by the lambs in this experiment were very satisfactory indeed although they were not kept in suitable fattening quarters, the only place available at that time being a very damp basement. At times some of the lambs suffered from colds, which fact accounts for the loss of flesh brought to light by some of the weekly weighings.

The last weights were taken on April 27, and the lambs shipped on the evening of April 28 so as to be in Chicago for the Monday market. The experiment thus covered a period of nine weeks.

On account of the warm weather the lambs were sold before they were quite finished. Had the weather been favorable they would have been fed for about two weeks longer. Nevertheless they topped the market for wooled lambs for the day. They were sold by Clay, Robinson & Co. to Nelson Morris & Co., who very kindly slaughtered them in lots and made such tests as we requested.

Since the object of the experiment was to compare the fattening qualities of the different grains, all the lots fed received clover hay for roughness, this being deemed best for lambs as it contains some fattening properties and is well relished. In no case, however, would the lambs in this experiment eat the coarse stems. The hay and grain were weighed when fed. The feeding was done twice daily, at 8 A. M. and 4 P. M., the grain being given first. Care was taken to feed only so much

as the lambs would clean up well. In case any feed was left in the trough it was weighed back. The refuse hay was all weighed and subtracted from the amount fed.

Each lot of four lambs was kept in a pen about 10 × 20 ft. in size, having a trough for grain at one end and one for hay at the other. The pens were kept well bedded with straw. Salt and water were kept constantly before the animals. Each lot of four received about one pound of salt per week. No account was kept of the water consumed.

The lambs were weighed on Saturday of each week after having eaten the morning grain ration. In weighing the lambs a steelyard was hung from the ceiling above each pen and the lamb weighed was suspended by means of a double belly-band.

TABLE NO. 1.

Lot	Grain	Hay	Total dry matter	Gain	Nutritive ratio
1..........	450	207.5	576.49	118	1 : 8
2..........	459	166.25	554.21	133	1 : 4.3
3..........	497	135.25	557.30	120	1 : 7.4
4..........	470	125.25	524.83	100	1 : 6.1

TABLE NO. 2.

FEED PER 100 POUNDS AND SLAUGHTER TEST.

Lot	Grain	Hay	Dry matter	Quality of meat	Per cent. of dressed weight
1..........	381	175	488.5	Third	55.4
2..........	345.1	125	416.7	First	53.1
3..........	414.1	112.1	464.4	Second	48.6
4..........	470.5	125.2	424.8	Fourth	47.

TABLE NO. 3.

AVERAGE INDIVIDUAL FEED AND GAIN PER DAY, IN POUNDS.

Lot	Grain	Hay	Gain
1..................................	1.78	.82	.46
2..................................	1.82	.65	.52
3..................................	1.89	.53	.47
4..................................	1.86	.49	.39

Table No. 4.

Individual Weights at Beginning and End of Experiment.

	Lot No. 1				Lot No. 2			
	No. 69	No. 70	No. 71	No. 72	No. 67	No. 73	No. 74	No. 75
First weight	71	73	64	72	68	71	73	66
Last weight	100	99	93	106	97	107	113	94
Gain.....	29	26	29	34	29	36	40	28

	Lot No. 3				Lot No. 4			
	No. 68	No. 76	No. 77	No. 81	No. 78	No. 79	No. 82	No. 81
First weight	68	71	73	73	75	73	75	60
Last weight	93	107	100	105	101	94	107	81
Gain	25	36	27	32	26	21	32	21

In Table 1 the feed and gain of the four lots are summarized, the dry matter and nutritive ratio being computed from the tables in Prof. W. A. Henry's "Feeds and Feeding." From this table we see that Lot 2, fed on corn and gluten meal, made the greatest gain of any of the four lots, and that Lot 4, fed oats as the only concentrate, made much the poorest gain of the four lots. Since the gain made by Lot 1 was much lowered by one poor lamb it seems safe to conclude that the fattening value of these grain feeds is, first, corn and gluten meal; second, corn; third, corn and oats; and fourth, oats. Furthermore, Table 2 shows that, pound for pound, oats is not nearly so valuable as a fattening feed as corn. Table 2 also shows that the corn-fed lambs, receiving the narrowest ration, ate the most clover hay. The mixture of corn and oats fed to Lot 3 seems to have left them with a much smaller appetite for clover hay than that possessed by those fed on corn alone.

By comparing the amounts of dry matter consumed by the four lots, as shown in Table 2, we see that Lot 2, receiving corn and gluten meal, required much less dry matter per pound of gain than those lots receiving a wider ration. The amount of dry matter required per pound of gain increases in this experiment as the amount of protein in the ration decreases.

The greatest gain made by any lot was put on by Lot 2, fed corn and gluten meal, with the least amount of dry matter and the highest percentage of protein. The greatest gain made by any individual in the experiment was also in this lot. No. 74 made a gain of 40 pounds in 63 days, the lamb weighing 73 pounds at the beginning of the experiment. Hence we see that considering dry matter consumed the most economical gain was made by this lot fed on corn and gluten meal. Unfortunately for the feeder, dry matter in the shape of gluten meal is an expensive feed for fattening lambs.

Table 2 also shows that Lot 2 produced the highest quality of mutton. Had Lot 1 not contained one very poor individual, however, it would have been placed ahead of No. 2 in quality. Oats seems not to produce a good quality of fat mutton.

Regarding the percentage of dressed weight of carcass to live weight of animal we see in Table 2 that the corn-fed lambs dressed a higher percentage than any other lot, with the corn and gluten meal lot second, the corn and oats lot third, and the oats-fed lot fourth.

Table 3 shows that these lambs put on some remarkable gains, and Table 4 gives the individual gains made by the 16 lambs used in this experiment.

In conclusion it may be said that the result of this experiment favors the use of shelled corn and clover hay for the fattening of lambs, as these feeds produce a first quality of mutton with a high percentage of dressed weight.

DISTEMPER.

By Chas. E. Walcher, Special in Agriculture, 1901.

The State of Illinois is a great producer of horses, especially of heavy horses, and as many of them are injured or incapacitated for work by the disease called distemper, attention is here called to some facts concerning this disease, and also to a method of treatment of afflicted animals.

Many stockmen fail to realize the importance of proper care of animals suffering from this common disease. A large portion of the thick-winded horses known as "roarers" have been injured by distemper. It is notoriously contagious, and may be carried from one barn to another on the clothing of an attendant.

Distemper appears in the form of a fever accompanied by a cough and a sore throat. Sometimes the fever is very slight. The animal appears dull and listless and often seems to be chilly. At the end of about two days there is a blue discharge from the nostrils, thin at first, but gradually becoming thicker and of a sticky nature. At this time the fever disappears and often a tumor forms under or just back of the jaws.

The animal has great difficulty in swallowing food, especially liquids, some of which will be ejected back through the nostrils. Frequently the mucous membrane of the larynx becomes inflamed. If such cases are not properly treated they are liable to leave a thickening of this membrane, which will interfere with breathing and cause "thick wind" or "roaring" and thus render the animal unfit for fast or hard work. Abscesse may be formed by this disease on any part of the animal's body. When near the external surface they seldom result seriously, but internal abscesses are usually fatal.

When horses or colts show symptoms of a cold or distemper they should not be worked or driven but should be put into a

warm ventilated stall, should be blanketed, and fed good nutritious food, such as oats, bran-mash, and slightly moistened hay. If the animal has fever give it half an ounce of nitrate of potassium in drinking water twice daily. For colts one year old use half this quantity. The potassium nitrate reduces the fever and acts on the kidneys. For very light cases this treatment alone would be sufficient, but if there is much fever with a harsh cough additional measures will be found necessary. Rub the legs well and bandage. This bandage should be removed and the legs rubbed twice daily. Steam the nostrils by placing one half ounce of camphor gum in a bucket of boiling water and holding this under the horse's nose for ten or fifteen minutes. A blanket loosely thrown over the animal's head and the bucket will confine the vapors somewhat and make the treatment more effective. Repeat this last treatment three times daily. Camphor being a volatile substance will pass with the steam into the larynx and bronchial tubes, thus soothing the inflamed parts. The throat should be gargled with two drachms chlorate of potassium and one teaspoonful of fluid extract of belladonna dissolved in one pint of cold water. To gargle the animal's throat hold its head up, pour a portion of the solution into its mouth, and move the tongue about to induce swallowing. If the animal coughs, let the head down immediately. Continue the gargling till the pint of medicine is all used. Repeat this gargling three times daily. A rope from the front of the halter to a ring or hook in the ceiling will be found convenient for holding up the horse's head during this treatment.

If an abscess forms, poultice it with warm linseed mush, changed once a day and kept moist by frequently adding a little warm water. Continue to poultice till the abscess becomes soft, then lance it and syringe it out with half an ounce of carbolic acid in a pint of water. This cleansing should be repeated two or three times a day till the place heals.

As this disease usually reduces the animal's vitality, benefit can be had from administering a tonic. Mix and divide into twenty-four doses, four ounces of nitrate of potassium, four ounces of sulphate of iron and two ounces of nux vomica. Give two doses daily in a small bran-mash with some oats. One half

of this last dose is enough for a colt one year old. If the appetite of the animal fails, administer three times daily, in a quart of oat-meal gruel, one ounce each of tincture of gentian, ginger, and chloride of iron. If the discharge from the nose should continue, steam the nostrils as above but substitute one ounce of turpentine for the camphor. If this treatment is faithfully carried out the animal will recover with unimpaired breathing power.

AMERICAN APPLES FOR THE MARKETS OF THE WORLD.

By J. E. Raymond, B. S., Class of 1899.

The fruit-growing interests of the United States are very large and are expanding rapidly. Of some fruits we are already raising more than we consume and are finding a market abroad. If, then, we are to compete in foreign markets we should know something of the conditions under which the fruits of our competitors are grown.

It is important that we understand that North America is a land of fruits. It is the leading fruit-growing country of the world, because vast areas are available for the business, and fruits are grown on a large scale. This means that they are grown cheaply, and that the product is of sufficient quantity and uniformity to attract attention in the markets. It is the large basis upon which American fruit-growing is established which enables us to enter European markets.

In Europe the various fruit growing centers are unique.

The business is the outgrowth of centuries of local effort and tradition. There are difficulties or barriers of race, language, political system and physiography. Uniformity of method and result is therefore practically impossible. In North America we speak one language and live in practically one political and social environment.

Although the apple is not a native of American soil, it seems to find a congenial home in the major portion of the United States and in large areas of the adjacent territory of British America. No fruit known to the cultivator in the north temperate zone can take the place of this apple as a food product. Many other fruits, indeed most cultivated fruits, rank as luxuries, but the apple in most parts of the United States is one of the leading products of the farm, and in many localities it is an article of marketable merchandise. In its numerous varieties its season of maturity extends throughout the year. No other fruit in the temperate zone may be had in continuous succession without resorting to artificial means of preservation. It is preëminently useful in household economy. As a culinary fruit none can excel it. It graces the table in a greater variety of forms than any other, and as a dessert fruit it has few equals and no superior.

The first step in the discussion of marketing is a classification of the purposes of the enterprise. If we regard the objects in view, there are two kinds of apple growing ; that for home use and that which is primarily for market. Of market, or commercial apple growing there are again two types; that which has for its aim a special or personal market, and that which is for the general or open market. The ideals in these two types of apple-growing are very unlike, and the methods and the varieties which assure success in the one may fail in the other.

The man who grows apples for the special market has a different problem before him. The product is not desired for its intrinsic qualities, and special products command special prices. The man who grows apples for the world's market has no personal customer. The product is desired for its intrinsic market qualities; and the world's products bring the world's prices. The special-market grower generally works on a small basis; the

world's-market grower on a large one; or the latter sells to another who by combining similar products of many persons is able to command the attention of the market. One grows either for a special and personal market,—in which case he looks for his own customer and is independent of general trade, or he grows what the market demands and allows the machinery of trade to handle the product. With the latter method the American apple grower is eminently successful; with the former he has made little more than a beginning. In the staple or large-area crop the demand regulates the supply; whereas, in products which are essentially luxuries, amenities and accessories, the supply largely regulates the demand. The world's staples are breadstuffs, meats, and materials for clothing and building; and in fruits there are some types or varieties which are staples for that group, —staples in the sense that they are adapted to cultivation over wide areas and to be sold in the general and open markets. The Willow Twig and Ben Davis are staples; Benoni and Early Harvest are accessories.

It follows, then, that general or staple products find their best outlet in general and open markets; special and accessory products find their only outlet in particular and personal markets. This law is well illustrated in the market for glass-house products. In France this industry of growing fruits under glass has become quite highly developed. Grapes, peaches, nectarines, plums, and even apples and pears are grown under controlled conditions. These products are disposed of at fancy prices for dessert purposes only and, as we have said, to a market limited by the supply. In this country we might possibly grow dessert apples on dwarf stocks with profit, but they could not compete in the home market with stored apples for culinary purposes, and it is very doubtful if they would ever be of importance in the foreign trade.

For our orchard-grown apples on a commercial scale we may expect the market to increase. I have already outlined the reasons, as they appeal to me, for the development of apple growing in the United States, and at the same time given reasons why we can enter the European markets. It only remains to add that the European consumers desire our fruit.

At the Paris Exposition in 1900 the U. S. Department of Agriculture made a continuous display of apples of the '99 crop from May 9 to October 21. Some apples of the season of 1900 were shown, but the greater part of the display was of storage fruit. Apples were shown from twenty states, in quantity, and attracted the attention of throngs of interested visitors besides receiving numerous prizes and compensations from the Jury of Awards. It is very encouraging that this opportunity of bringing our American-grown apples to the notice of Europeans was so well improved; for not only was it valuable in bringing the fruit to the attention of the foreigners, but the opportunity of studying varieties best adapted to long storage and the best packages and methods of packing, beside the practice in making effective displays will, we hope, prove of great advantage in the development of our foreign trade.

The English are now well acquainted with our apples, and fruit buyers on the continent, particularly in Germany, are learning to know them. The foreign market is only fairly opened; it is not yet supplied. Many people in Europe have come to believe that the European fruit-growers cannot compete with the American in general-market fruit, and they are looking for a growing trade in American produce. It is also the opinion of the leading experts in this country that European fruit-growers cannot compete with us in apples, and probably not even in pears and some other fruits.

The readers of the *Agriculturist* are doubtless aware that Illinois is rapidly becoming a prominent apple-growing state. Probably nowhere else in the world is there in one state or country 35,000,000 acres of land so well adapted to the production of this king of fruits, and so favorably situated for it. It is indeed the exceedingly wide acreage suitable for commercial apple production that is destined to make Illinois the first state in the Union in this as in so many other respects. It is true that there is some choice within our borders of soils and conditions most favorable for orchards, but apples can be successfully grown in more than four-fifths of our territory. Our state extends through five and a half degrees of latitute, and there is considerable diversity of soil. It is evident that, as in the production

of any other crop, attention needs to be given to local conditions. Certain varieties of apples do better in the southern, others in the northern portions, and different soils require different treatment for the best results.

The apple growers of Illinois have loyally supported their state society and are taking a hearty interest in keeping their produce before the public.

In the report of Senator Dunlap, commissioner in charge of the Illinois apples at the Paris Exposition, we find the statement that "the marking on the Illinois fruit was higher than that of the fruit from any other state in the United States or Canada, on two occasions being marked 18, on another 19, and once 20, on a scale of 20. In addition to the prizes awarded during the exposition, Illinois received at the close a Grand Prize for the continuous exhibit of fruit throughout the exposition."*

Will the orchardists of Illinois not make the best of the opportunities acquired as a result of their efforts?

In the large available area, the intelligence of her orchardists in growing and packing, the tested long-keeping varieties grown, and facilities in prospect for storage and transportation no state is the peer of Illinois; and we predict none will surpass her in the future as a producer of American apples for the markets of the world.

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*Trans. Ill. State Hort. Soc., Vol. 34 (1900), p. 158.

AGRICULTURE AT THE UNIVERSITY OF ILLINOIS.

By J. Orton Finley, Class of 1904.

Illinois has builded an enduring monument to herself by erecting a separate building for her College of Agriculture. This was the greatest step in the progress of agriculture ever taken by the state. Never before have the fundamental principles and the higher education been so prominent a feature in the demands of agriculture as at the beginning of the present century. It was at this time, after a long and hard struggle for a building and equipment, that Illinois was able to say to the young men and women of the state: "Successful farming is rapidly becoming the vocation of trained minds; the college is the main source of all training which lies beyond the ordinary farm practice." In order to meet the response to this appeal the college has had to increase its instructional force from seven to twenty in the past two years.

The departments in the college are: Animal husbandry, dairy husbandry, horticulture, agronomy, household science, and veterinary science. Each department has a head with a number of assistants. It may not be out of place to say here that only technical subjects are taught in the Agricultural College, and that students taking the graduating course are required to take studies which are taught in the other colleges.

The aim of this college is to fit its students for the business of farming, and at the same time give them a general college education. Therefore, the course is both technical and cultural. It seeks to train the students not only to be successful farmers, but to be useful citizens as well, and in doing this, it gives an education suited to the needs of rural people.

The technical training comprises half of the entire course. In studying the technical subjects, the aim is not so much to teach rules of practice as to make plain the principles of agricultural science. Of the remaining portion of the course nearly one-half is prescribed in the sciences. Since the technical subjects are also of a scientific character, the course as a whole is essentially scientific rather than literary. Yet the college is mindful of the educational importance of history, literature, language, and the political sciences, and reasonable attention is given to these subjects. One strong feature of the course is the laboratory work. The students spend nearly half of their time in experimentation, to supplement the work of the text books, lectures, and reference readings. The object of the laboratory method is to bring the student into close contact with his subject by practical application.

In the animal husbandry department three instructors give courses covering the separate study of beef-cattle, sheep and swine, and their products; light and heavy horses with their care and training; the management of farm herds; and the principles and practices of breeding and feeding. The object is to familiarize the student with animals—first, as to their fitness for specific purposes; second, as to their care and management; third as to their improvement by breeding; and fourth, as to the commercial production of animal products. This knowledge is gained by the study of the uses of domestic animals, the history and character of the breeds, with practice in stock-judging, and a careful study of the methods of successful stockmen and the known principles of breeding. At present the University does not own sufficient stock to give all the needed instruction in the study of the different kinds of live stock, but through the kindness of breeders and shippers from all parts of the state, many choice animals are sent to the University for special study by the students. The students also take advantage, as far as possible, of fairs and stock shows, and here, as nowhere else, can one get an opportunity to study the different breeds and types.

In the dairy department three instructors give courses in the study of milk and its economical production, the characteristics

of the dairy cow, the management of the dairy farm, the separation of milk, the making of butter and cheese, factory management, dairy bacteriology, city milk supply, and the standardizing and pasteurizing of milk and cream.

In horticulture several instructors give courses in orchard management, small-fruit culture, vegetable gardening, floriculture, landscape gardening, forestry, propagation of fruits, evolution of cultivated plants, and commercial horticulture and nursery management. The purpose is to acquaint the student with the principles of fruit raising and vegetable gardening, and with the successful methods of combating insects and fungous diseases. The sense of the beautiful is cultivated in floriculture and landscape gardening to the end that more of nature's beauty shall pervade the home and its surroundings.

A larger force of teachers gives instruction in the department of agronomy. The subjects relate especially to the field and its affairs, as drainage, farm machinery, field crops, physics and bacteriology of the soil, manures, rotation and fertility, the history of agriculture, farm management, and comparative agriculture. The object is to make the student familiar with the facts and principles connected with the improvement of soils, the preservation of fertility, the nature of various crops, and the conditions governing their successful and economical production.

The course in household science gives a scientific study of some of the problems of house-keeping and home-making, together with the management of the home, and the distribution of the income according to recognized business principles. This course is given to meet the needs of two classes of students: first, those who wish to specialize in other lines of work, but desire a knowledge of general principles and facts of household science; second those students who wish to make a specialty of household science by a comprehensive study of the affairs, care, and management of the home.

The courses offered in veterinary science are anatomy, physiology, materia medica, theory and practice of veterinary medicine and surgery, and the science of veterinary sanitation. These courses familiarize the students with the structure and activities of the animal in health, the characteristics and symptoms

of disease, and the material and methods for successful treatment. He therefore makes a critical study of the structure of domestic animals, and of the nature of their derangements and the characteristic action of remedial agents, and the weekly clinics give opportunity for practical experience in treating the more ordinary diseases.

In all the courses given in the different departments it will be seen that the student does a large amount of laboratory work, supplemented by lectures, recitations, and use of reference books. The students who enter the College of Agriculture are from the farms, the towns, and the cities. Some of them have had a common school training, others have graduated from high schools, while a few have finished a college course. Entering under these conditions, in order to graduate the first named must do at least two years' preparatory work and spend four years in the University proper. The high school graduate can enter as a freshman provided his school is on the accredited list and sufficient work has been done to give him entrance credits. In order to graduate, the college man must study from two to three years, his work being nearly all technical, since he has taken the more general studies before entering the University.

The course, as has been said before, requires more than technical knowledge for graduation, but many do not realize the value of receiving other training than in agriculture. Here is where some are apt to make a mistake; for in getting a technical education one should not neglect the training he needs to express himself clearly and distinctly, as well as to be informed on other subjects.

Starting, then, with the young man entering college, it is only a matter of time, if he applies himself, until he sees the relation between the college and the farmer, between the experiment station and the college, and the need of training in the subjects indirectly connected with agriculture. I do not say that all the indirect studies or subjects can be made interesting to him, but he looks upon them as necessary for equipment. The studies that are most interesting are those which open a new life to one.

More is often expected from the agricultural student than

should be, considering the time he is allowed to spend in college. The public does not realize that it takes as much time to train the boy for the farm as it does to educate the lawyer, the doctor, or the engineer in his profession. However, the young man who cannot take a full course is not to be discouraged, but should be encouraged to take advantage of even a shorter period.

Let us ask the question: will an agricultural education fit a young man as thoroughly for self-sustaining citizenship as will the preparation for the so-called learned professions? A ringing answer to these questions is found in the following extract from the speech of Mr. L. H. Kerrick at the dedication of of our Agricultural Building:

"The schools have been turning out too many doctors, too many lawyers, too many professors. There is no need for them all, but they have been taken too often from the farm where there is need of them. The professors have rather the best of it, because they go on turning out more doctors, and more lawyers, and more professors. To say the so-called learned professions are full, pressed down and running over is only hinting at their actual condition. Something over a year ago I read in a Chicago paper an account of graduating exercises which took place at the University of Chicago. Let me quote you verbatim a part of President Harper's address to the graduates, as it was reported: 'You, who are entering the world, will find that poverty will be the strongest opponent to overcome. You, who are entering life as lawyers, need only to look at the papers today to find the average lawyer does not earn his salt. Those who will become physicians will find their only companion for a few years to come will be the wolf at the door. While those who go forth to teach need only to witness the struggles of the school teachers in this city. The school board is beset with howls and wails for an increase of salaries."

"This is that great, and rich, and growing metropolis, Chicago, a city affording as great, or greater, and more opportunities for men and women trained for the learned professions than any other city. Yet, even there, the prospect held out to those graduates by the president was starvation. If some other fellows had not the strength to fast as long as these graduates,

then they might eventually get the other fellows' places.

"The first duty of an educated, able-bodied man is to make his own living. The man who is not in some way, at some point, doing an amount of the world's necessary work equal to that required for the support of one man, is a burden to society.

"Do any of you fear that President Draper or Dean Davenport will ever say to a class graduating from their Agricultural College: 'Gentlemen, you are going out to the farms. You have not mastered the whole of agricultural science. That will not be done by any living or yet to live, but you have done your work well in the college, and you are well equipped for your business. However, I feel obliged to say to you that poverty will be the strongest opponent you will have to overcome. The average farmer does not earn his salt—that is for his personal consumption, mind you, let alone the cattle and horse critters. The only companion you will have for some years to come will be the wolf at the door.'

"I just as much expect to read of such a speech having been made here, to a class graduating from this Agricultural College as I expect to find myself tomorrow morning sitting on some distant star reading that last night the cables of gravitation parted down here and the whole planetary outfit fell to everlasting smash."

It is no longer a question with those interested in agriculture whether they can afford to attend the Agricultural College, but, rather, can they afford to miss the opportunity for the improvement this institution offers.

THE WHEATLAND PLOWING-MATCH.

By Jane M. Mather, Library, 1902.

From the time our father Adam was sent forth to earn his bread by the sweat of his brow, from the first stirring of the ground with some primitive tool, up through the line of walking, sulky, gang, and steam plows, there have been plows and plowmen. There is something of poetry and religion in thus stirring up the virgin soil; in getting down to elemental things, in delving first-hand into the secret processes of nature, and the worthy plowman must truly feel that "the earth is the Lord's and the fulness thereof." The poetry of it, the fresh smell of the up-turned clods, the sweetness of the world around, and the joy of living so near our great mother, everything tends to make this the ideal work of the farm, and because plowing is of such importance as the first step in agriculture our Wheatland farmers built better than they knew when they instituted the Plowing-Match.

Some of the early inhabitants of Wheatland had attended plowing-matches in Scotland and England. They proposed to have such a contest here, and accordingly a meeting was held in the little white school house, and a day and place appointed for the contest. On that day, September 22, 1877, the farmers, some seventy-five men assembled at nine o'clock. Each man who wished to plow brought his own plow and team. The following rules had been decided upon at the first meeting for conducting and regulating the contest: 1, Only residents of the town can compete. 2, Boys can compete for all prizes. 3, Each person entering shall be required to plow half an acre within three and one-half hours. 4, No plowing is to be under five inches in depth.

There were three men appointed as judges. They were to consider straightness, neatness and evenness of furrows. The lands were staked off and numbered, the competitors drawing lots for places. The place of meeting was a field near the school-house. The spectators tied their horses to the fence and visited while the plowing was being done. The committee remained in the school-house until the time came to judge the plowing. After the decisions were made the names were read in order. Seven prizes were given; the first, fifteen dollars and all amounting to forty-four dollars. After the prizes were awarded dinner was served in the school-house, and in the afternoon there was an exhibition of sulky plows.

The first plowing-match was so successful and the men seemed to have enjoyed themselves so much that some of the good housewives announced their determination to go the second year. They went accordingly with the well-filled lunch baskets and since that time plowing-match day has been a holiday for the town of Wheatland. Each year the number of people increased and it became necessary to choose a farm having a good water supply and a large number of shade trees in addition to a good field for plowing.

New features have been added as the project has grown, one, a dining-tent, where for twenty-five cents can be had a dinner made up of prize cooking. And such a dinner! It is a joy to the man from the city who has no farmer friends, and it is a golden opportunity for the politician who wishes to secure a few votes. The ladies bring for the dining table baskets of food which are given prizes according to the quality and quantity of the good things they contain. The money taken at the dining-tent—sometimes one hundred dollars—is used for expenses and prizes for the Ladies' Fair, another most important feature. Here prize cooking, needle-work, fancy-work, and choice flowers and plants are exhibited. The Wheatland ladies' cooking is far famed. Prize cakes, pies, and cans of preserves are sold to the gallant gentleman by an auctioneer, and this money is also given to the Plowing-match Association. The Ladies' Fair has awakened great interest in cooking and other housewifely arts. Girls can compete for all prizes, and some special ones are offered

them. There is an exhibition of chickens; also of grain and potatoes.

These features have been introduced one at a time, and farmers are especially interested in all of them. The Plowing-match Association appoints a committee of men who have charge of a " stand " where pop-corn, candy, and ice-cream are sold, and the money made there pays for the prizes for plowing, grain and chickens. A prize is given for the best kept farm and road, and this is a great incentive to activity. Farmers work early and late cutting weeds, mowing the grass along the roadside, and mending fences.

The Plowing-match Association is self-supporting, and while it means hard work for a good many people, it means pleasure to a great many more. The number in attendance on the twenty-fourth annual plowing-match, in 1901, is estimated to have been about 6,000, and some years the crowd has been estimated at 10,000. Of course this growth has been gradual, and to one who has not seen it, it is incredible. One wonders why all these people come to the plowing-match. They are not interested in plowing, we know. Sometimes they say it is because they see so many friends and acquaintances; sometimes it is only curiosity; and sometimes it is to watch the crowd, curious because it is made up of so many kinds of people. It is for the farmer a day—perhaps the one day in the year—when he can visit with his friends and neighbors. The busiest one accepts this as a long holiday.

This large institution has grown out of the effort of a few progressive farmers. They thought only to see which of their neighbors were the best plowmen. They had only rude, primitive plows, sometimes made by the village blacksmith, but satisfactory at that time. As the plowmen improved they wanted new and better plows. The farmers went to the plow companies but they had none that were satisfactory. What the plowman wanted was one he could adjust to meet his individual needs. After a time these men ordered plows made as they wanted them and in recent years the plow manufacturers have asked some of the most skilled plowmen and farmers to come to their shops and make suggestions for perfecting their plows.

They realize that they must improve them to meet the demands of a people with whom plowing has become a science and an art. The effect has been far reaching. These improved plows are being sent to all parts of Illinois and the United States. Agents from the various companies exhibit their plows at Wheatland, and they pay the best plowmen to use them because it is a great advertisement to have theirs win first prize. Twenty-two men, all farmers, came to the plowing-match from the southern part of the county and twenty of them bought the kind of gang plow that won first prize.

The influence of the plowing-match has really been phenomenal. It is ordinarily supposed that it is almost altogether a social function. The social feature is an important one but hardly of chief importance. Not only plowing but other processes of farming are carried on in new and better ways on account of it. The farmer who has learned to plow straight and evenly and takes pride in it, will want to plant his corn in straight rows. It has engendered in the farmer a neatness and thrift that is evident in every part of his farming.

To this contest come farmers from many parts of the county and state. The best and most progressive ones from other parts of the country are naturally the most interested and they exchange ideas with the Wheatland men and both are benefited. As one drives through this section of Illinois, one can but notice the well-plowed fields, neat fences and roads, and well kept houses and yards.

To conclude, the Wheatland farmers are intelligent and thrifty; they do not quit their farms and move to town as do so many prosperous farmers in other localities, leaving their farms to less intelligent renters. The plowing-match is one of the influences which has made Wheatland a place where farmers would rather live than in town. Striving to be the best plowman, to raise the best corn, and to have the best kept farm has raised a spirit of friendly rivalry among the farmers of Wheatland. Let this spirit prevail in other parts of Illinois, and let us make our state one where any intelligent and thrifty citizen will find it a pleasure to live in the country.

SOME PRINCIPLES RELATING TO THE SOIL.

BY WM. G. ECKHARDT, CLASS OF 1905.

Agriculture is of primary importance, both to the individual and to the nation. As nations advance in population and maturity this truth becomes more apparent and renders the cultivation of the soil more and more an object for public patronage. Institutions for promoting the growth of agriculture have grown up and are supported by the public. Civilized man has come to depend upon the earth for a variety of needs, of which the primal and most important are served by the soil. Although climate, geographical position, and the resources of the deeper earth have much to do with prosperity, the character of the soil as regards endurance of tillage, and the crops which it will nurture are of the first importance, for, as statesmen have said, "The nation that feeds the world rules the world."

Although our land is still of almost virgin fertility, a heedless neglect of our duty toward it has led to the destruction of the soil over an area in the United States of probably 4,000 square miles. This means a loss of food-giving resources which would be sufficient, with proper care, to supply a population of about one million people.

First of all we must remember that the process by which we obtain crops from the soil is an unnatural one. In a state of nature all that the vegetation takes from the earth is promptly returned to it by the process of decay. Therefore it is necessary to limit as far as possible the tax laid upon the earth in our artificial treatment of it and to provide in every practicable way for the replacement of the substances removed by the harvests.

If one would acquire a visual evidence of the difference between the conservative condition which prevailed in the soil be-

fore the interference of man and the destructive state which exists afterward, he should during a time of continued rain resort to some stream which drains a country that is but partly tilled. He would there observe that the streams which drain the district where tillage prevails are heavily laden with fine particles of soil. Here and there we find a stream which, though swollen by rain, lacks all such matter. On investigation it will always be found that clear streams drain valleys in which the primitive forest is unbroken.

It has come to be a recognized fact that the humus or organic matter is a very important part of the soil. It performs a number of different functions in the soil which are of the highest importance in crop production. It influences its temperature, tilth, permeability by water, absorptive power, weight, and color, and controls either directly or indirectly, in a high degree the supply of water, nitrogen, phosphoric acid, and potash. The most important difference, physical or chemical, between the composition of old, worn soils and new soils of the same character is in the amount of humus which is present.

Humus is our principal source of nitrogen, which it always contains, and is also an important source of lime, phosphoric acid, and potash. Of the three principal elementary plant foods nitrogen, phosphoric acid, and potash, nitrogen is the most abundant in nature, the hardest to get, and the easist to lose. It is as necessary to plant life as oxygen is to animal life. Four-fifths of the air we breath is nitrogen, but atmospheric nitrogen is not available for plant food until it has been changed into the form of a nitrate, and this must take place in the soil. No plants are known which are capable of using atmospheric nitrogen directly, although the leguminous plants—clover, peas, beans, lupines and vetches—can, through microscopic organisms that live upon their roots, use the free nitrogen of the air.

The humus of the soil is decreased by cultivation without the addition of humus-forming materials. This loss, involving a loss of the nitrogen, and also a change in the physical condition of the soil, rendering it less capable of holding water. A soil rich in humus not only absorbs more water but holds it better in a time of drouth than one poor in humus. The humus of

the soil may be much increased by the use of well prepared farm manures, and by the turning under of sod and green crops.

Through its decomposition humus provides the crop with available plant food and it assists materially in bringing about the physical conditions in the soil best suited to the growth of plants. It is also favorable to the growth of bacteria, which are often useful to plants ; and its loss from the soil is always attended by a marked decline in productiveness.

But of all the factors influencing the growth of plants, water is the most important. Plant growth depends largely on four factors : heat, light, food, and water. If these are furnished in just the right amounts and at just the right time a maximum crop may be expected. If, however, any or all the factors are deficient or excessive the crop will be impaired. In field culture heat and light cannot well be controlled, but food and water may be to a certain extent. All our agricultural plants obtain their water exclusively through their roots ; and therefore a well-developed root system is of the highest importance. There is usually a rapid development of these organs in the early period of growth, and if the proper moisture conditions are present at this time the chances are that a root development favorable to the future growth of the plant will be attained. When we know that for every pound of dry matter formed in plant growth from three to four hundred pounds of water are used by the plant we can appreciate the necessity of saving soil water. This enormous amount of water acts as a medium of transportation of plant food, aids in the chemical and biological changes that take place in the plant, is plant food in itself and it also serves as a temperature regulator for the plant.

In aiming to control soil moisture two distinct lines of operation may be followed : one to conserve the moisture already in the soil by different modes, times, and frequencies of tillage, and by the application of mulches ; and another to increase the amount of water in the soil by increasing its water-holding capacity, and by strengthening the capillary movement upward. Fall plowing has a very appreciable influence on the per cent. of water which the surface three or four feet may contain the fol-

lowing spring. This is due partly to two causes: first, to the open character of the overturned soil, which causes it to act as a mulch during the fall, and again in the spring after the snows have disappeared; and in the second place to the more uneven surface which tends to prevent the running away of the melting snow and early spring rains. There is no one thing more important, however, than the earliest possible stirring of the soil in the spring after it has dried sufficiently not to suffer in texture from puddling. It is then that every farmer has seen the effect of a week's difference in the time of plowing. The earliest plowed land not only retains more moisture but is free from clods and requires much less labor in preparation. When the soil is wet, when its texture is close from the packing which has resulted from the winter snows and the early spring rains the loss of water is very rapid owing to surface evaporation. Whenever a lamp is lighted there is at once started a current of oil rising from the lower bowl through the many interstices between the threads of the loosely woven wick, and this flow continues as long as the oil is removed from the upper end by burning. So, too, when a wet soil is exposed to a drying wind the removal of water from its surface results in setting up a flow of the ground water upward toward the drying surface. By tillage this upward rise of water is retarded just as the flow of oil in a wick would be stopped by a break in its fibers.

It often happens in spring that hot dry winds come before there is an opportunity to plow the land to save the moisture and prevent the formation of clods. In such cases the timely use of the disc-harrow will do much to save the moisture and prevent the baking of the soil. The disc-harrow is one of the best tools for early spring use to work the soil and develop mulches.

The forming of a perfect mulch is an all-important factor in the saving of soil moisture, and the effectiveness of soil mulches as a means of diminishing evaporation varies with the size of the soil particles, with the coarseness of its structure, with the thickness of the mulch, and with the frequency with which the soil is stirred. Sandy soils form more effective mulches than do clay soils, and their greater effectiveness in this connection goes

a long way toward making the smaller amount of water they are able to retain, effective in crop production. In the early part of the season the warming and aeration of the soil, and the killing of weeds are important objects to be attained, and it is very important to cultivate frequently. This is the season of the year when the effectiveness of mulches decreases most rapidly; it is the season when there is less danger of destroying the roots of the crop by cultivation; and it is the time when cultivation is needed to help develop plant food. Whenever a rain has occurred which has thoroughly united the soil crumbs one to another and with the soil below, it is time to cultivate again if this can be done without too heavy root pruning, and it should be done just as quickly as the soil will permit. After a light rain, however, the immediate cultivation of the soil will not be of value in saving the rain which has just fallen, but it will save that previously in the ground by again forming the mulch.

The principal object of plowing is to loosen up the soil for four purposes: (1) to enable the soil to absorb the rainfall more quickly and freely than it would in its undistributed condition; (2) to maintain more of the rainfall near the roots of the plants; (3) to admit fresh air to the roots; and (4) to enable the roots of the young or quickly growing plants to penetrate the soil more easily. The principal objects of subsequent cultivation are (1) to kill the weeds which use up great quantities of water; and (2) to keep the surface covered with a loose dry mulch in order to prevent, so far as possible, the loss of water by evaporation.

AGRICULTURE IN COLORADO.

By E. S. G. Titus, Asst. to the State Entomologist.

It has become nothing unusual at the present day for different sections of the country to have their carnivals of one nature or another to advertise their staple crops or manufactures. In the western states this is more true than in the East, and it is so especially in the mountain states, and in none more true than in Colorado. This state has such a peculiar topography that the agricultural regions are often completely separated by mountain ranges. The great plains in the east sloping up to the foot-hills, from which here and there a river rushes through a narrow gorge; the mountain-river and creek valleys; the mountain parks; the fertile land "over the range,"—each of these possesses its own set of people, and each has its own mode of farming.

For many years Colorado was known as a mining and grazing country only; but the ranges are fast changing into cultivated irrigable farms, and the state is becoming an agricultural and horticultural region. In the northern part Greeley has "Potato Day" and Boulder "Strawberry Day," each drawing many people to the feasts each year; Loveland has been for several years giving a "Corn Roast Day," although her sudden change to a sugar-beet country may affect that some, as this year she had a very successful "Sugar Day." A few miles farther south is Longmont with "Pumpkin Pie Day"—and what a glorious feast! Along the Arkansas, far to the south, is Rocky Ford, made famous over the country by her melons, and "Melon Day" is a feature that draws visitors from many sections and many states. Later in the year its sister town, some distance down the river, gives its "Annual Rabbit Day." Hundreds of thousands of rabbits have paid the death penalty, and still rabbits are left to await the days and the hunters to come.

Passing over the range we have "Peach Day" at Grand Junction, and, again, a "Strawberry Day," this time at the world-famed resort of Glenwood Springs. A more recent celebration but none the less interesting and attractive is "Game Day" at Steamboat Springs, where the guests are regaled with fine venison, bear-steak, and such delicacies of the season from woods and stream as can only be had on the outskirts of civilization. This does not end the list, even after the "Grand Flower Parade" at Colorado Springs and the "Silver Serpent's Carnival" at Denver are mentioned ; but from those given it may be seen that each section is providing for its own crop by thus judiciously advertising its good properties.

The main stock industries are cattle-raising and lamb-feeding. The principal cattle ranges are now somewhat scattered. In the southern part of the state, in the plains district, some native cattle are still kept ; but the improved breeds have made much headway in the foot-hill region farther north and in the larger parks. The earlier importations were Durhams, but more lately Herefords have come into great favor. Some polled cattle were tried but were not popular, though most of the feeders dehorn their cattle.

At one time most of the available range of the state was open and free, but of late years it is not so. In one large mountain valley—the San Luis, a valley the size of Rhode Island and New Jersey combined, and surrounded by mountains where summer ranging is good*—the winter often sees 250,000 head of cattle driven down for feeding. Cattle-men were not slow in seeing that the springs and headwaters of streams furnished the key to the range. This later resulted in one man's controlling an immense range of 20,000 to 25,000 acres by merely securing the few quarter-sections controlling the water supply. This and the coming of the small farmer have changed conditions, so that now few herds in this region exceed 300 head. Notwithstanding the owner has by no means a chance to relax precautions. He must now keep as good or a better watch than ever lest the "rustler" come along and the little herd pass out of existence, so the cowboy rides the range and the "round-ups" occur as in

* '96—Cooke, Bull. Colo. 34, page 4.

days of yore. When near good winter ranges feed (hay) is given only when necessary, at times when severe snow-storms and blizzards appear and cover up the grass, driving the cattle off the feeding grounds. Rangers, and indeed most farmers, feed hay on the ground. Little is wasted; there is less crowding, and all concerned can get their share, for feeding room is practically unlimited. About the only serious enemies are the "rustler" and the gray wolf, equally bad and equally hard to dispose of. Many cattle are only grass or hay-fattened before being sent out of the state.

The sheep-raising and wool-growing industries frequently occasion much trouble between cattle-men and sheep-men over the use of the range. These troubles sometimes lead to serious results, fatal affrays, and the driving of bands of sheep over a precipice to be dashed to pieces on the rocks. Lamb-feeding is a business that has rapidly come to the front during the past ten years and assumed enormous proportions. There are two main feeding sections in the state: the Cache le Poudre and the Big Thompson valleys, with headquarters at Fort Collins; and the Arkansas valley district, with headquarters at Las Animas and Rocky Ford.

A visit to the sheep pens in the winter presents a sight long to be remembered. Most of the lambs are shipped in from New Mexico, beginning to arrive at the northern district in early September and coming in until in November. Here they are held until late winter and early spring, then reloaded and sent to the eastern markets—Omaha, Chicago, and even New York and New Jersey points. The lambs are fed on alfalfa hay for some time and then given a very small allowance of grain, the latter being regularly increased until they are eating "full feed," all they care for and take readily. The alfalfa racks are of boards, low, from 12 to 14 feet wide, and of almost any length. The hay is pitched into the center and pushed out to the sides as the sheep need it. Room enough at the racks is given to prevent crowding, but no extra space is desired, for in that case animals will be running from place to place. The grain-feeding is done in separate pens From 400 to 500 sheep are let into a yard at a time, the grain having been previously put in the troughs, and are allowed

ten to fifteen minutes for feeding and then driven back, the troughs refilled, and another bunch let in to eat. From 600 to 5,000 may be fed on a single ranch, and there have been instances where larger bunches were fed. A few sheep from Wyoming, often driven overland, are fed each year, and some Oregon sheep have been brought in. The total number fed runs from 125,000 up to about 200,000 for different years. The great majority go to Chicago markets.

Prominent among the agricultural industries stands sugar-beet raising and its natural consequent, beet-sugar making. Several costly plants have been established in the state, in the Arkansas Valley, at Grand Junction and at Loveland, and several others are vigorously prospective. The Grand Junction beet-men were treated to a bad scare a few years ago when the "Beet Army-worm" (*Laphygma flavimaculata*, Harv.) made its appearance in countless numbers, literally cleaning up the fields. When beet leaves ran short they burrowed into the beets, seriously injuring them, or else cleaned up weeds, potato plants, and even started on the leaves of trees. Prof. C. P. Gillette, the State Entomologist, went to the infested district and started the growers to using the arsenical poisons. They were effective and the insects were soon under control. However, thousands of them had pupated, and many moths appeared that fall; but for some unknown reason the next spring did not bring the expected invasion. The following summer the growers at Rocky Ford and Lamar had the first brood in destructive numbers, but prompt action on the part of all interested soon quelled the outbreak. The poisons were found by the Assistant Entomologist, E. D. Ball, to be quite effective, especially where two sprayings of Paris green were made.* The factory superintendents, as well as the beet-raisers, coöperated in doing everything possible to save their crop.

The fruit interests of Colorado are quite extensive, apples, peaches, pears, plums, apricots, and cherries, and almost all the small fruits being successfully grown in different parts of the state. If only as much energy were shown by orchardists in getting rid of or protecting themselves against insect pests as

*1900—Rep. St. Ent. Colo. for 1900, p. 6.

was shown by the sugar-beet people, there would be many more fine apples and other fruits. Not only is this true in the west, but even more so in the central states. The cankerworm is not known to occur in Colorado as yet, but the codling-moth, the woolly-aphis, the plum-gouger, and others of like proclivities, keep the orchardist from having too much perfect fruit. Too many people, all over the country, think that all they need to do is to plant a tree and let it alone, and that the fruit will come along sooner or later. It does, but what fruit! Too many trees of that character give any section of the country a bad name for knotty, wormy fruit. "Irrigate" is a term, though western, that is coming to have a meaning in this connection, and I once heard a young fellow remark as he was running the pump-end of a spraying-outfit: "Say, are you going to irrigate those trees"? The amount put on seemed to him excessive. If only more of that class of irrigation were done it would be advantageous to all concerned. Those orchardists of Colorado who have conscientiously sprayed their trees have very few injured apples. But this means that the work must be done at the proper time. Something else must wait. This has resulted in Colorado in much specialized farming; in the raising of such crops as fit into each other as far as work is concerned.

I have written these few notes in order that agriculturists here in Illinois may have a chance to note what I hope will be points of interest to them from another section of the country, just a few picked out of many.

PORK PRODUCTION IN ILLINOIS.

By D. S. Dalbey, Class of 1902.

The chief center of the world's swine producing industry is in the more northerly states of the Mississippi Valley. In spite of the fact that pork is despised by many and is shunned by the devotees of several religions, the importance of pork production in Illinois is only second to that of corn.

The development of the hog to his present state from his wild progenitor has been very rapid, owing to the fact that he is very plastic and susceptible to influence by favorable conditions for development. In the wild state the hog is very active and even aggressive. He has a long snout, formidable bristles, and is almost equal to a race-horse in respect to speed. This wild type was domesticated by our ancestors, and the present type has been produced by many years of selection and favorable environment. The snout has been reduced to a mere stub, the bristles changed to hair, and the legs shortened, until we now have a blocky, thick-meated, docile animal, almost entirely dependent upon man for his subsistence.

Prior to 1850 there was but little uniformity in swine, except that they were white and slow in maturing. There were innumerable varying breeds, each a favorite in some county or section of the state; and size, regardless of excessive offal or cost of production, was the one object sought. At present nine-tenths of the American hogs are either red or black, with small markings of white on the face, feet, and tail. In the type now required color does not signify, but the hog that converts its feed into the most and best pork, and which yields the greatest returns in the shortest time is the desideratum.

The swine of our country have received their improvement largely through English breeders, but in America the conditions

as regards methods and feeding are so widely different that the course of development of the American hog from his English progenitor is considerably changed, and the producer of pork in Illinois has problems to confront quite different from those the English farmer meets. This is largely due to the adaptation of Indian corn to some sections of the United States, and a study of the production of hogs in our country as regards numbers brings out the fact that there is a great interdependence existing between corn and hog production. For instance, in 1898 the twelve packing states, Illinois, Ohio, Indiana, Iowa, Missouri, Kansas, Minnesota, Nebraska, Wisconsin, Michigan, Kentucky, and Tennessee raised over 20,000,000 hogs, while in the remaining states there were less than 19,000,000 hogs raised. On the other hand, there were produced that year in the above-named twelve states 1,500,000,000 bushels of corn, as against 450,000,000 bushels in the remaining states. Another fact that brings out most strikingly the close relation existing between corn and hog production is a comparison of their variations in price. In the report of the Secretary of Agriculture for 1890, the author shows by a diagram the relative prices of hogs and corn for seventeen years, from 1872 until 1889, and in concluding he says: "The price of hogs increased with the price of corn without regard to the amount of hog product placed upon the market. After an advance in the market of corn and hogs for a series of years, the price of corn dropped one year before the decline came in the price of hogs."

In view of the foregoing considerations, the question arises as to the cause of this close relationship between corn and hogs, and we naturally inquire whether no other farm products can be so successfully produced for swine feeding as Indian corn. It is a fact, however, in this connection that corn is relished by hogs for a longer period than any of our other food products. Further, corn is perfectly adapted to our soil and climatic conditions, and it is also a crop which cleans the ground, corresponding in this respect to the root crops of England, though corn may be grown much more cheaply and at less expense of soil fertility. Again, corn is more highly productive of nutriment than any other feed that we raise here in the corn belt.

The following table shows the composition of the feeds available for hogs in Illinois :

TABLE I.

COMPOSITION OF AMERICAN HOG FEEDS.

Feed	Yield	Amount per Acre	Dry Matter	Digestible Nutrients: Protein	Digestible Nutrients: Carbohydrates	Digestible Nutrients: Fat	Nutritive Ratio
Corn	Grain...	3,000	2,673	237	2,001	129	1 : 9.7
	Stover..	3,000	1,790	50	975	21	1 : 19.9
Total	....	6,000	4,463	287	2,976	150	
Oats	Grain....	1,200	1,068	111	568	51	1 : 6.2
	Straw....	1,500	1,362	18	579	12	1 : 33.6
Total	....	2,700	2,430	129	1,147	63	
Wheat	Grain....	1,200	1,075	122	831	20	1 : 7.2
	Straw....	1,000	905	4	362	4	1 : 93.
Total	....	2,200	1,980	126	1,193	24	
Alfalfa	4 tons	8,000	7,328	440	1,584	48	1 : 3.8
Red clover	2 tons	4,000	1,165	115	590	28	1 : 5.8
Cow-peas	25 bu.	1,500	1,278	275	813	17	1 : 3.1
Soy-beans	35 bu.	2,100	1,873	622	469	302	1 : 1.8
Rape	10 tons	20,000	3,735	300	1,620	40	1 : 4.1

A study of the foregoing table, together with the consideration of the fact that corn seems best suited to the appetites of hogs, helps us to understand why the pork-producing industry has been so largely influenced by the production of corn, and it would seem at first glance that this valuable grain should supersede all other hog feeds. Indeed, many farmers in Illinois and the states farther west have depended almost solely upon corn as the feed for their hogs during the growing, fattening, and finishing periods. It is maintained by these feeders that the cheapness and richness of corn are qualities which render it too economical a feed to allow others to replace it even to the slightest extent. Fortunately, this idea is rapidly passing away, and it is now pretty generally conceded that the hog ration cannot be limited exclusively to corn.

This change in the methods of feeders can be attributed to several causes. The loss to the farmers of this state alone, of several hundred thousand hogs annually through cholera and swine plague has driven them to investigate the causes which

make their hogs so susceptible to these dreaded diseases. The conclusion generally arrived at is that the exclusive feeding of corn is largely responsible for the great prevalence of cholera among hogs. In his "Diseases of Swine," Dr. McIntosh says: "Corn alone has not sufficient albuminates (protein) and salts, and has too much starchy substance which is converted into fat, and is, therefore, a grain which is not fit food for a young and growing animal. It is necessary to feed other materials which contain albuminates to supply the deficiency of this material in the corn. And I am satisfied that the prevalence of cholera among pigs in the corn-growing states is in a great part due to the feeding of too much corn. In Canada, where the pig is mostly fed on peas and oats and the refuse of wheat and rye, cholera is unknown."

The reason for this is still a problem for the experimenter, but a possible explanation might be offered in the fact that the exclusive feeding of corn heats up the whole system and produces an inflammation of the mucous membrane of the stomach and intestines, leaving it in a condition favorable for the develepement and rapid multiplication of the cholera bacteria. Another effect of the exclusive feeding of corn is seen in the lessened growth and vigor and excessive fatness and sluggishness of the animal, the weakened constitution leaving the system in such a condition that it is unable to withstand the attack of the cholera germs.

Thus it is seen that in the feedlng of swine there should be a balance between the protein (the bone and muscle producing nutrients) and the carbohydrates and fat (the heat and fat producing elements). The results of numerous feeding experiments along this line indicate that for fattening swine this relation between the protein and fat, called the "nutritive ratio" (determined by adding the digestible carbohydrates to 2.4 times the digestible fat and dividing this sum by the digestible protein), should be one part protein to 6.5 parts fat.

Referring to Table I we see that corn has a nutritive ratio of 1:9.7 which shows an excess of carbohydrates and fat, and it is evident that in feeding such a ration there would be very little growth, and excessive fattening alone could result. On

the other hand, suppose that instead of feeding corn exclusively, a feed high in protein is mixed with it. Then the deficiency of protein in the corn would be supplied, and a feed that satisfies more of the body wants is the result. At the Kansas Station experiments were made in feeding pigs with corn meal alone, and with corn meal ⅔ and soy-bean meal ⅓ with the following results: *

TABLE II.

Feed	Av. weight at beginning	Daily gain per head	Grain eaten	Gain	Grain for 100 lbs. gain	Gain per bu. feed.	Per cent. feed saved by using soy-beans
Corn meal, lbs....	64	.80	1477	306	482	11.6	
⅔ corn meal.... ⅓ soy-bean meal	62	1.46	2048	554	369	15.5	23.7

From these results it is very evident that soy-beans, fed as an adjunct to corn, make a very profitable ration, as the average gain of the pigs was materially increased, and the requirements of feed for 100 lbs. gain was cut down, making a saving of nearly 24% of the feed. Soy-beans are extremely rich in protein, as is evident from their nutritive ratio 1:1.8, and so blend very well with corn to balance the ration.

Mr. C. A. Rowe, of Jacksonville, Ill., has kindly given me the results of a very careful experiment with pasturing pigs on soy-beans during the past summer. The pigs were turned in and allowed to "hog down" the beans after they were ripened, and in addition to the beans some corn was fed to the pigs. The beans were planted June 1 in rows two feet apart, using between one-half and three-fifths of a bushel of seed per acre. The field consisted of 4.79 acres and was cultivated twice. Mr Rowe gives the following figures and results of the experiment:

On September 11, turned in 132 pigs weighing 10,180 pounds.
On October 7, turned off 132 pigs weighing 14,366 pounds.
Gain.. 4,186 pounds.
Gain per day.................................. 1.25 lbs. each
108.65 bu. corn fed during time and counting
10 lbs. pork for each bu. corn.............. 1,086 pounds.

*Bull. No. 92.

Subtracting 1,086 from the total gain of 4,186 pounds, the shoats gained on beans 3,100 pounds, amounting to 647 pounds of pork per acre, which at the present price of pork, 6c. per pound, amounts to $38.82.

Cow-peas have also been found to be a valuable adjunct to feed with corn. The Alabama Station* made an experiment with three lots of pigs, feeding respectively, corn, cow-peas, and a mixture of the two for sixteen weeks, with the following results :

TABLE III.

AVERAGE RESULTS OF FEEDING PIGS CORN, COW-PEAS, AND CORN AND COW-PEAS FOR SIXTEEN WEEKS.

	Average weight at beginning	Feed eaten. lbs.	Gain. lbs.	Feed for 100 lbs. gain
Lot I., Corn	58	844	173	487
Lot II., Cow-peas	60	954	198	481
Lot III., ½ corn and ½ cow-peas	62	909	210	433

The results of this experiment indicate that corn and cow-peas are practically equal for young and growing pigs, but that a mixture of one-half each makes a much superior feed to either alone. It should also be noted in this connection that during the first two or three weeks of the experiment Lot I (corn alone) made larger gains than Lot III (corn and cow-peas), but as the experiment progressed Lot III made much the heavier gains, showing that on any diet in which the proportion between the growth-producing and the fat- or heat-producing elements is not properly balanced the normal growth of the body cannot take place for any length of time.

Experiments have been made with feeding pigs on corn, corn with oats, and corn with green feed, with the result that the largest gain was made with the lot fed on corn and green feed, while the smallest was made by the pigs fed on corn and oats. Practically the same amount of corn was consumed by the lot fed corn alone as by the lot fed on corn and green feed, but much less corn was eaten by the lot fed on corn and oats, show-

*Alabama Bull. No. 82.

ing that while the addition of green feed to a corn diet augments the gain without reducing the amount of corn consumed, the addition of oats reduces the amount of corn eaten by the animal, and at the same time reduces the gain.

The results of these experiments plainly indicate the value of cow-peas and soy-beans for hogs both as green feed and matured seed, and of clover, alfalfa, rape, and other green feeds as a supplement to corn for pig-feeding. The crops are cheap and easily raised, and while corn is the cheapest and most economical hog feed we can raise here in the corn belt, yet when fed alone it does not furnish all the elements necessary to the normal growth of the hog. Consequently, if the Illinois farmer will make judicious use of such of these supplementary crops as are easily available to him, and pay the close attention to the wants and comfort of his hogs that they require he will soon be convinced of his great dependence upon the production of pork for his profits on the farm.

THE NATURE AND USES OF OUR PEAT BOGS.

BY H. E. WARD, M. S., CHIEF ASSISTANT IN SOIL BACTERIOLOGY.

It is a frequently quoted saying that Illinois is a great rich state. It is affirmed that she has been endowed by nature with all the conditions essential to the greatest agricultural productivity and development. This feeling has been so prevalent in the past and still influences the public mind so strongly that it is not strange that the Illinois farmer should have come to be possessed of a certain sense of security in the inherent properties of his soils. I have serious reason to believe that the wastefulness which has characterized some of the agricultural practices of the state has been largely due to this feeling. Not only has it produced this result, but it has also been largely responsible for the non-development of large areas of lands whose natural conditions did not adapt them to the immediate cultivation which was possible on the broad prairies which occupied so large a proportion of the area of the state. It was but natural that the large tracts of peat bogs and swamp soils located in various portions of the state should be regarded as waste lands and receive but little attention so long as there was an abundance of land surrounding them which could be made to yield a quicker and highly satisfactory return with less expenditure of labor and capital. It is largely owing to this fact that our peat bogs, which often belong to our most valuable and enduring soils, have come in many sections to be looked upon as worthless tracts, possessed of no agricultural value whatever.

It is true that the soils of Illinois have been of such vast extent and so abundantly supplied with the essential elements of fertility that the agriculturist has had but slight occasion to concern himself with the more intricate problems of soil exhaustion or of the utilization of the latent resources of these

waste lands, but that these conditions are rapidly changing is evidenced by the steady decline in the productive capacity of our fields, and by trials which have shown that these unimproved types of soil can in many cases be used for agricultural purposes with great profit under existing conditions.

Probably the most important type of unimproved lands, and that including those which are most susceptible of being brought into a productive condition with a slight expenditure of labor, is that class of soils usually characterized as peat, muck, or marsh-land. These terms are, in common usage, applied somewhat indiscriminately to all of the various types of soil which are found in low or wet areas or where the conditions have been favorable to the accumulation of a large proportion of humus or vegetable mould in the soil. The term peat is more properly restricted, however, to that type of soil which has resulted from the drainage or gradual filling up of old lake beds with the remains of aquatic vegetation, or from the gradual conversion of upland into humus soils by climatic changes which have caused the accumulation of vegetable remains in the soil to take place more rapidly than the process of decay has tended towards their removal.

While it is true that Illinois has according to the census of 1890 a larger proportion of improved land than any other state excepting Ohio, yet it is well for us to remember that almost 30 per cent. of her 56,000 square miles were still unreclaimed at that time. This means that there are over 10,000,000 acres of the total area of the state which contribute little or nothing to its agricultural wealth, and of this amount it is estimated that above 25 per cent. is comprised in the extensive peat bogs, which are found principally in the northern half of the state. Leaving out of the consideration that portion of our peat soils which has already been reclaimed, it appears from the above calculations that we have over two and a half million acres of these soils which still remain as vast store-houses of wealth which have yet to be opened to the uses of agriculture. The possibilities that are to be realized by the improvement of these lands may be more apparent perhaps if we recall that this area would have sufficed for the production of the entire hay

crop of the state for the year 1896, or would have been more than was needed for the entire wheat, barley, and rye crops, according to the acreage given by the Illinois crop report for that year.

While there is an almost limitless variety in the kinds of peat to be found in the state so far as their composition may be concerned, there are two distinct types, to be found in every peat bed, which demand our attention. The distinctions upon which these types are based relate more to their physical properties and arrangement in the bog than to any essential difference in their constitution.

The first of these varieties to receive our attention on visiting a peat bog, is that which occurs always on the surface of the bog and is known usually as loose or powdery peat, or as the "dry peat layer." It is usually of a dark reddish-brown color and a light friable texture, and shows a soft spongy consistency when tramped upon. The color may vary widely among peats from different regions or with peat from different parts of the same bog, and it is not infrequent that we find this layer of a distinctly reddish, or even of a bright red, hue. In addition to these peculiarities this portion of the bog, which usually comprises the surface six to twelve inches, is distinguished by another very important property, which is shown by pressing a piece of blue litmus paper against the surface of the moistened peat. If this test is carefully made it will be found that the litmus paper has not been changed in color, this indicating the absence of acid properties in this portion of the peat.

Beneath this layer of powdery peat is found another, which is composed of a mass of material presenting widely contrasted physical characters. This lower substratum varies in thickness according to the depth of the accumulation, and is made up of a much denser and wetter mass than the surface layer. It is possessed of a tough cheesy consistency which causes it to crumble with difficulty when dry, and, in fact, in many cases forms masses of almost stony hardness if dried rapidly and completely. It may be characterized as possessing a soapy or slippery feel, by its soiling the hands when handled, and by changing blue litmus paper to a distinctly reddish tinge—showing the

presence of acids. This cheesy peat or "cheesy muck," as it is often called, contains usually from two-thirds to three-fourths of its weight of water, and the remainder is often almost wholly made up of the partially decomposed woody tissue of plants. On this account it has been dried and used extensively for fuel in regions where it was abundant and other forms of fuel were scarce.

In applying peat to any soil for its fertilizing or physical effects several facts already noted regarding its nature must be borne in mind if the most satisfactory results are to be attained. It has been observed that the peat from the lower layers of the bog is usually acid and does not readily disintegrate when it becomes dry, and if applied to the soil in this condition is it of very little or no value. In fact it would in the majority of cases remain as large lumps on the surface, and form a positive detriment to the soil. To avoid this it is necessary that the cheesy peat from the lower portions of the bog be thrown out on the surface in the fall and exposed during the winter, or, better still, till the next fall, to the weathering action of the atmosphere. In this way the acidity of the peat is overcome by the ammonia of the air, and it loses completely its sticky and adhesive nature, breaking down into the loose, pulverulent form which is found on the surface of the bog. This change is also accompanied by the loss of the larger part of the water, which makes up from 50 to 80 per cent. of the material before it is exposed to the action of the weather, and becomes a very obvious saving of expense in applying it to the field.

As it often happens that serious mistakes are made by attempting to break up a peat bog at once and subdue it by sowing grain crops, it may be well to indicate briefly some of the more important points to be observed in the handling of such lands, as well as to call attention to some results which have been obtained by different methods of treatment.

The first step in reclaiming a peat bog is to thoroughly drain it to the depth of 3 to 3½ feet. This is very essential, not alone for the removal of the surplus water and for the consequent warming effect on the peat, but to permit the needful aëration of the upper layers of peat. It must be remembered

that in order to become fertile and of such a character that the roots of agricultural plants can thrive in it, the acid condition of the peat must be overcome, and this is only brought about by enabling the air to enter it freely. Drainage also causes the peat to settle and become consolidated and of a less spongy texture, a change which is of much importance to the proper warming of the soil, as the very loose condition of the raw peat tends to prevent the passage of heat downward by conduction. This change is accompanied almost immediately by a corresponding change in the character of the vegetation, and where only wild grasses and water-loving forms had previously existed the redtop, blue-grass, and other useful species soon find conditions favorable to their development. The extreme "frostiness" of the ground, or its tendency toward heaving and toward acquiring an exceedingly loose condition as a result of the alternate freezing and thawing of the winter weather, a condition which is so destructive to certain crops, is largely overcome by thorough drainage.

It is worthy of note here that it is often possible by simple drainage and seeding to redtop—which can usually be easily accomplished by harrowing in the seed after the rubbish has been removed from the surface of the bog—to secure a permanent meadow which will often furnish an abundance of hay of a good quality for years with no further outlay than the trouble of harvesting the crop. These natural meadows are almost entirely depended upon for the entire hay crop in some regions, and it is found that this use of the ground aids greatly in preparing it for the growth of grain and other crops.

In many bogs, when the surface is covered by a dense growth of coarse grasses mixed with shrubs of various kinds, it becomes necessary to remove this mass of material, which would otherwise form an obstruction to the use of the ground. The cheapest and most effectual way of accomplishing this end is usually to burn the ground over. In case this method is adopted, however, it is essential that considerable care be exercised in the choice of the proper time for setting the material on fire. Great damage often results to the future usefulness of the bog if this burning is done during the dry summer season, owing to the fact that the

peat readily takes fire under these conditions and may burn for months, and to a depth which removes all of the dry surface layer, leaving only the raw acid peat below, which is totally unfit for the use of crops. On this account it is best to burn the ground over a few days after a soaking rain, when the easily combustible materials on the surface will readily burn, while the peat is protected by the large amount of water which it retains.

It often happens in our larger peat bogs, and in those which have received little or no drainage from the surrounding country during the process of formation, that the mineral elements of fertility exist in the peat in a very small proportion. It is a well-known fact among those who have had any considerable experience in the cultivation of these soils, that a more or less pronounced deficiency in these elements is one of their most striking characteristics. The cause of this deficiency becomes apparent when we recall the method by which the peat has been produced. Taking for illustration any of our larger areas of peat, it is evident that no mixing of earthy matters can occur during the process of formation, excepting at the edges, where the washings from the surrounding uplands have become mixed and deposited with the peat. As the great preponderance of the material in the case of that formed by the filling up of old lake beds has resulted from the continual growth of aquatic species at the surface of the water under such conditions that it was impossible for their roots to reach the bottom of the lake, or obtain mineral food other than that carried in solution by the water, it is evident that the conditions have tended towards the burial of the earthy materials at the bottom of the lake beneath this mass of ever-deepening vegetable substance. It may be asked where these peat-forming plants obtain the mineral food necessary to their existence as this process goes on, and the generally accepted theory is that so long as water remains in the lake it furnishes all of these elements which are needed in the soluble form, while the constant decomposition of the surface layers of peat, after the complete filling of the lake, liberates the mineral elements used by previous generations of plants with sufficient rapidity to supply the demands of the growing vegetation. In this way it is seen that a very small proportion of these

elements is used over and over again to serve the needs of succeeding generations of plants whose roots tend to preserve this mineral food at the surface as the bog gradually fills, by extracting the last traces from the mass of vegetable matter below.

Remembering this fact it is easy for us to understand why our peat bogs after being brought under cultivation often produce two or three paying crops and then utterly fail to respond to the best tillage till mineral fertility has been added. It is evident that the first few crops removed from the ground have taken all of the available mineral food and left nothing for succeeding crops. It is owing to this condition that such a marked effect is often produced in the productive capacity of some of our peat bogs by the application of a small amount of mineral fertilizers. In this connection it may be instructive to note by way of illustration some results obtained from a study of the effects of applying kainit to certain peat soils in Illinois which belong to the type just considered.

A large peat bog near Manito in Mason County consisting of several hundred acres which has resulted from the gradual filling in of a former lake bed was found to produce two or three excellent yields of corn or root crops while succeeding crops rapidly diminished in amount and soon failed entirely. It was commonly found upon these fields when planted to corn that the seed germinated readily, giving a very even stand and promise of an excellent crop, while a few weeks later the plants ordinarily showed signs of a lack of thrift, becoming stunted in appearance, and of a sickly color. This condition tended to become more marked as the season progressed, and a larger or smaller proportion of the plants eventually died, leaving a very poor stand, and in some cases only a few scattering stalks here and there as discouraging reminders of disappointed hopes. It was commonly noted that the plants which survived made a very meager and inferior growth, and showed a marked tendency to remain barren, only occasionly one producing an ear.

These indications pointed so strongly towards the conclusion that the peat was deficient in mineral fertility that samples were taken and subjected to analysis by the Chemical Department of the Illinois Experiment Station with the results given below :

ANALYSES OF PEAT BOG SOILS.

Element	Knollhoff farm	Conover farm	Avr. 200 fertile soils
Insoluble matter.... ..	11.15	11.74	79.95
Organic matter	76.94	76.81	7.00
Lime (CaO)	.241	.405	2.16
Potash (K_2O)	.078	.070	.29
Soda (Na_2O)	.112	.154	.25
Phosphoric acid (P_2O_5)	.238	.241	.24
Nitrogen.	3.359	3.382	.29

From a study of the percentages obtained as a result of the analyses of two samples of the peat as indicated above, it will be seen that while there is a comparative abundance of lime and a relatively large amount of phosphoric acid, the proportion of potash is much lower than that found in soils of average fertility. It is also interesting to note in this case the percentages given for organic matter and nitrogen.

As more conclusive evidence that the barrenness of these soils was due to a deficiency of the mineral elements and chiefly to a lack of potash, it should be stated that kainit was applied at the rate of 300 pounds per acre to the Knollhoff ground from which the sample represented by the analysis in the first column of the preceding table was taken, while the ground from which the other sample was taken, lying just over the fence from the fertilized tract, had never received fertilizers of any sort. Both pieces were planted to corn and tended in a similar manner. The comparative stand of the crop on each and the character of the growth is well illustrated by the photo-engravings in Figs. 1 and 2. These photographs were taken on August 27, when the corn had reached its maximum development, and represent average portions of each field so far as it was possible to determine by careful examination. On the same date the corn which stood on a measured square rod of each field, selected so as to represent the average conditions in each case, was cut up, photographed and weighed, and in Fig. 3 the shock to the left which weighed 235 pounds represents the corn from the ground that had received the kainit, while the smaller shock shown in the figure, whose weight was but 49 pounds, represents the yield of one rod from the unfertilized field. The relatively small dressing of kainit

FIGURE 1.

FIGURE 2.

FIGURE 3.

which was applied and which is chiefly valuable for the potash which it contains is thus seen to have produced a most remarkable increase in the crop of corn; nor was this the only crop which was benefited by its application, for it was found to be equally valuable when applied to crops of oats, rye, potatoes, and roots.

Many writers advocate the use of slaked lime on freshly-subdued peat bogs at the rate of from 30 to 50 bushels per acre, and there is no doubt that in the great majority of cases it can be profitably employed, especially in regions where it can be obtained at little expense. It frequently happens that deposits of marl are found mixed with the peat at different depths and occasionally near enough to the surface so that it can be readily hauled out and applied to the peat. This material is composed to a greater or less degree of the carbonates of lime and magnesia, and often occurs in such purity that it can be used instead of more expensive forms of lime to great advantage.

It has frequently been observed that peat bogs which had formerly been unproductive were brought into a fruitful condition by the use of liberal dressings of barn-yard manure, and some have attributed this benefit to the alkaline matters, and mineral ingredients contained in the manure. While there can be no doubt that these are partly responsible for the beneficial effects observed, it is also probable that the processes of fermentation and decay started by the addition of the manure also contribute largely toward the production of the wholesome effects.

As an example of the influence of farm-yard manure when used for this purpose an experiment conducted by Prof. F. H. King, of the Wisconsin Experiment Station, may be profitably considered.* Farm-yard manure at the rate of 34 loads per acre was applied in alternate strips to two peat bogs, leaving every other strip unmanured for means of comparison. The ground was planted to corn, and when the crop was harvested it was found that the total yield of dry matter per acre had been increased as a result of the application of the manure, as shown by the accompanying table. It will be seen that the total yield of dry

*Wis. Rep., 1896, p. 178.

SHOWING NUMBER OF POUNDS OF CORN GROWN ON MANURED AND UNMANURED PEAT BOG.

Experiment	Manured	Unmanured	Difference
Number 1.............	7,622	3,597	4,025
Number 2.............	9,085	5,354	3,740

matter was in the first case increased over two tons per acre or to more than twice as much as was obtained from the unmanured land.

Serious errors are often made at the outset by attempting to grow the wrong kind of a crop on the newly broken peat bog. Small grain crops seldom succeed well for the first few years, and many times any attempt to grow them results in failure. Winter grain crops, as wheat or rye, are especially unfit for growth as the looseness of the peat and its great tendency to frostiness and heaving during the winter usually cause them to freeze out badly. Spring grains, as oats or barley, may succeed better and are often well adapted to the more mixed types of peat, but they frequently fail on the purer forms of peat owing to the excessive amount of nitrogen usually contained in these soils, which causes them to produce an extreme growth of straw with little or no grain. As has been previously stated, redtop generally finds the conditions highly favorable to its development and is often one of the most profitable crops that can be raised for the first few years. In the older eastern states where hay commands better prices, many farmers have accumulated a comfortable fortune by raising redtop hay upon reclaimed peat bogs. The timothy crop also succeeds well after the bog has become sufficiently settled so that the roots do not freeze out too badly during the winter. Corn is usually a staple article of production on our peat bog soils where the season is long enough so that it comes to maturity under these conditions. It does not suffer injury from an excessively nitrogenous dietary, and owing to its hardy feeding qualities it can better adapt itself to comparatively adverse conditions than the more delicately constituted small grain crops.

If one is located near a ready market or where the transportation facilities are good, these soils can usually be most profit-

ably devoted to the growing of some of the more intensive forms of crops, such as the truck or garden crops. They are admirably adapted to the growth of such crops as cabbage, potatoes, onions, and various forms of roots. In some of the northern states very large returns are obtained from the culture of special crops, such as cranberries or celery, upon these soils.

After reviewing hastily a few of the principal uses to which our extensive areas of unreclaimed peats are naturally adapted, it is difficult to avoid the feeling that it is a great misfortune that so much potential wealth should be made to contribute nothing to the advancement of society. One prominent writer has said*: "Muck and marl would make a good team for many a poor farm." Is it not to be hoped that our farmers who are located in regions where these soils abound may come to better appreciate the truth of these words, and, appreciating, may learn to yoke this refractory team and train it in obedience to their will, so that their sons and daughters may realize more fully than they have done the tremendous possibilities which lie buried in these soils in the way of future happy homes?

EXPERIMENTS WITH FARM CROPS.

By O. D. Center, Class of 1903.

The division of Farm Crops of the University of Illinois offers to its students a course in field experiments. Mr. Shamel, who is at the head of this division, had, in the spring of 1901, a large class in this course, to which he gave daily lectures, while the field work was carried on by Mr. Null, who planned and supervised the following experiments. This work was done on the experiment farm, on a tract comprising about eight acres, the soil of which is a rich, black, prairie loam of glacial origin. This tract was laid off in plots of uniform size, with cultivated strips between them. These plots were selected in such a way

*Mich. Sta. Bull., 115, p. 39.

as to give to each experiment a soil as nearly of the same nature as possible.

The first experiment was the treatment of oats for smut, and in this there were used eighteen plots of one-eighth acre each. Six treatments were tried in duplicate, so that two plots were sown with seed similarly treated. These eighteen oat plots were arranged in series of three, one plot of each series being sown with untreated oats to serve as a check on the others. The treatments used were hot water, formalin, sulphur smoke, carbon bisulphide, wood smoke, and coal oil. The worth of these treatments as a preventive of smut, and their deleterious or beneficial action on the germinating power of the oats is represented in the following table.

No. of plot	Kind of treatment	When sown	Am't of seed per acre	Date when half were showing green	Yield per acre	Per ct. of smut
1	Hot water........	April 15	2 bu.	April 28..........	49.2 bu.	None
2	Formalin.........	" 16	2 "	Did not germinate	*	......
3	No treatment.....	" 16	2 "	May 4............	40.2 bu.	2.25
4	Carbon bisulphide	" 16	1 "	May 5............	38 "	2.6
5	Sulphur smoke...	" 17	1 "	May 7............	31.1 "	None
6	No treatment.....	" 15	1 "	May 4............	35 "	3.98
7	Wood smoke	" 16	2½ "	May 5............	32.8 "	None
8	Coal oil	" 15	2½ "	May 4............	42.5 "	1.2
9	No treatment.....	" 15	2½ "	May 4............	46 "	2.
10	Hot water........	" 15	3 "	April 28..........	52 "	None
11	Formalin.........	" 15	4 *2 "	May 10...........	26.4 "	None
12	No treatment.....	" 15	3 "	May 4...........	44.5 "	2.15
13	Carbon bisulphide	" 15	1 "	May 4...........	40.8 "	1.7
14	Sulphur smoke....	" 15	1 "	May 7...........	46.1 "	.5
15	No treatment.....	" 15	1 "	May 4...........	20.8*3"	2.1
16	Wood smoke	" 15	2½ "	May 5...........	55.2 "	None
17	Coal oil..........	" 15	2½ "	May 4...........	50.4 "	1.8
18	No treatment.....	" 15	2½ "	May 4...........	40.1 "	2.15

*Note 1. The formalin used to treat the oats sown on plot two was too strong and destroyed the vitality of the grain. *2. The student having plot eleven treated the seed and then allowed it to stand two days before he sowed it. He then sowed it so thick that he covered but two-thirds of the plot. He then treated enough more seed to finish the plot, sowing by this mistake, at a rate of four bushels per acre. The oats that were treated and let stand failed to germinate more than two per cent. of the amount sown, while those sown immediately after having been treated grew as well as any of the oats sown on other plots. *3. Rape was sown with the oats on plot fifteen, and on account of the lateness of the spring, the oats made so slow a growth that the rape overpowered them to a considerable extent.

From the foregoing table it is readily seen that hot water and formalin are both successful preventives of smut. The formalin must, however, be used very carefully, or else the

vitality of the grain will be impaired. The hot water treatment is superior in at least one respect—on account of the start it gives to germination. The wood smoke treatment was successful this year, but as this was its first trial, we would not be justified in recommending it. The sulphur smoke treatment was successful on one plot and will, therefore, bear further investigation.

Another experiment conducted by two of the students was a "depth of planting" experiment. In this they took oats, clover, corn, soja-beans and cow-peas, and planted them at different depths. One row of oats, one rod long, was planted at each of the following depths: one-fourth inch, one-half inch, one inch, one and one-half inches, two inches, three inches, four inches, five inches, and six inches. Besides these there were two rows more, planted two inches deep, one of which was planted with large grains, the other with small. Four hundred grains were planted in each row, and then the row was divided so that each half row contained two hundred grains. These were all planted April 26. There were three counts made of the number of plants which came up. The dates of these counts are May 4, 8, and 16. On May 25 one-half of each row was thinned to forty good strong stalks, the other half being left just as thick as it came up. On Aug. 8 the oats were threshed, each half row separately, that we might ascertain whether there was any difference between the rows thinned and those not thinned. The following table is a summary of the results throughout the season.

Row number	Depth plant'd, inches	Number of plants			Weight of oats and straw, thinned	Weight of oats, thinned	Weight of oats and straw, not thinned	Weight of oats not thinned
		1st count	2d count	3d count				
1	¼	0	0	390	16¾ oz.	4 oz.	22 oz.	6 oz.
2	½	6	6	347	17½ "	4¼ "	23½ "	5¾ "
3	1	169	169	302	27¾ "	8½ "	24¼ "	7¼ "
4	1½	332	313	351	28¼ "	6½ "	27 "	8¼ "
5	2	337	340	391	29¾ "	8 "	26¼ "	7¼ "
6	3	329	340	387	27½ "	7¼ "	25¼ "	7 "
7	4	262	320	359	26¼ "	8 "	26¼ "	6¼ "
8	5	21	237	300	24¼ "	6½ "	25 "	6¼ "
9	6	0	168	232	24 "	5¼ "	19½ "	4¼ "
10 (large grains)	2	338	332	357	14 "	4 "	13 "	3½ "
11 (small grains)	2	275	275	291	11 "	2¾ "	15 "	3½ "

From the above table it is seen that rows one and two and eight and nine were about the same during the season and yielded equally well. Row number one would never have come up if rain had not come about May 10. From this table it may be seen that the oats planted from one to three inches deep gave the largest yield. The quality of the oats from the rows planted one and a half and two inches deep was very much better than that from any of the other rows. The oats sown six inches deep were puny, weak, and poor during the entire season, and also failed to ripen as they should. The half of the row that was thinned ripened much the best in every case and had less rust on it. In comparing the rows planted from large and small grains we find that the large grains gave better results whether thinned or not thinned.

The experiment with clover showed that the best stand was secured when the seed was covered not to exceed one-half inch, but that which was planted from one-half to one and one-half inches deep stood the drought much the best. The clover seed planted from two and one-half to four inches deep failed to come up.

On May 15 we planted eight rows of corn with sixty grains to the row. The different depths of planting were half an inch, one inch, and one and a half, two, three, four, five, and six inches. Ten days after planting a count was made, and it showed that the rows planted one and one-half, two, and three inches deep were up better, looked more thrifty, and gave promise of producing better stalks than the others. These three rows had an average of fifty-nine good, healthy stalks to the row, while forty-five was the greatest number of stalks to be seen on any other row in the plot. Each row was thinned on June 1 to twenty good strong stalks, and these were given the same cultivation during the entire season. On Sept. 25 the corn from each row was husked and weighed separately. The weights showed that the row planted three inches deep yielded the most corn; the row planted two inches deep stood second; and the row planted one and one half inches deep, third. The corn on rows planted two and three inches deep was also far superior in quality to that of any of the other rows in the plot.

The experiments with soja-beans and cow-peas were very similar to those with corn, and the results obtained indicate that the same depths of planting will secure the best returns.

From these experiments we are led to believe that the farmer, to obtain the greatest return for his labor, should endeavor to secure an even stand of oats, medium thick, and to get them placed in the ground from one and one-half to three inches deep. Further, that clover sown and covered one-half an inch deep will bring a better stand than if covered to a greater depth but will not, however, survive a drought as well. Corn planted from one and one-half to three inches deep will come up quicker, be more thrifty, stand dry weather better, and produce a greater yield than if planted at any other depth. The popular idea that deep planted corn will stand up better than shallow planted corn was not sustained by our experiment, for the rows planted five and six inches deep blew over much worse than the shallower planting. Another reason for not planting grains deep, is that the deeper they are placed in the soil the more difficult it is for them to secure a sufficient supply of oxygen. By experimentation we have found that where seeds are sprouted in an atmosphere of pure oxygen they not only germinate more quickly but the plumule is larger and stronger than when like grains are sprouted in air or in other gases, therefore, when we limit the supply of available oxygen by planting deeply, we are retarding the growth of the plant.

In our experiments with potatoes we used especial care in planting so that the results would be very accurate, but on account of the very dry summer the results are not as conclusive as they should have been. The first plot of potatoes was planted to two varieties, and under nine different conditions. The object of this was to study the habits and mode of growth, as well as to ascertain the best method of planting. The varieties used were Early Ohio and Early Michigan. Two rows were planted of each variety as follows: shallow, eyes up; deep, eyes up; planted on sand; planted under sand; planted in sand; planted in manure; soil, ordinary depth, eyes up; soil, ordinary depth, eyes down; and shallow planting with eyes down. All of these were given the same cultivation, and the results are shown in the following table.

How planted	Early Ohio: Marketable potatoes, lbs.	Early Ohio: Marketable potatoes, oz.	Early Ohio: Unmarketable potatoes, lbs.	Early Ohio: Unmarketable potatoes, oz.	Early Michigan: Marketable potatoes, lbs.	Early Michigan: Marketable potatoes, oz.	Early Michigan: Unmarketable potatoes, lbs.	Early Michigan: Unmarketable potatoes, oz.
Shallow, eyes up.........	7	..	9	13	11	..	19	8
Deep, eyes up.............	11	8	8	12	18	..	19	8
Planted on sand...........	14	8	9	7	23	..	19	..
Planted under sand.......	13	11	8	15	17	..	23	..
Planted in sand	12	4	9	4	12	14	21	..
Planted in manure........	7	5	6	..	9	4	7	4
Ordinary depth, eyes up..	17	8	11	6	17	8	20	8
Ordinary depth, eyes down	12	..	10	..	19	8	21	8
Shallow, eyes down.......	17	...	8	15	9	2	9	4

As the primary object of this experiment was to study the habits and mode of growth, we investigated these to a considerable extent, and arrived at the following conclusions: The stem of the potato comes from the seed-piece to the surface without branching, but with buds along its surface at regular intervals. As soon as the stem reaches the surface it begins to branch and form the top. The buds below the surface begin to grow to form tubers. From this fact we can readily see that if the distance between the seed-piece and the surface of the ground is small, but few buds can form, and consequently but few tubers can be produced; while if the seed is planted to a considerable depth, a larger number of buds are put out on the stem, and therefore, if the season is favorable, a larger crop of tubers will be produced. Again, all the potatoes form above the seed-piece; therefore if a loose or sandy soil is above the seed, the tubers can develop to better advantage. Further, the use of manure directly upon the seed is detrimental rather than advantageous, as it causes the potatoes to be scabby and ill shaped, besides inducing them to rot easily.

The remainder of our experiments with potatoes consisted of a test of ten varieties to see which would yield the most when planted under varying conditions. Naturally enough the potatoes which were mulched yielded the best, and of the varieties tested the Livingston excelled, producing at the rate of one hundred and thirteen bushels per acre. The potatoes that were

treated with corrosive sublimate solution for scab, showed that the treatment was satisfactory, as the tubers were smooth and free from scab.

In our work with corn we had a test of varieties and an experiment in detasseling. The variety experiment included five recognized breeds of corn, and utilized three plots of one-eighth acre each. The varieties were Silver Mine, Golden Eagle, Boone County White, Reid's Yellow Dent, and Leaming. Four rows of each variety were planted, but to give to each an equal chance of development we changed the order of planting in each plot. Further than this, we planted an excess of kernels, and then, when the corn was large enough, we thinned every hill to three of the largest, strongest stalks. After the first thinning we again counted the stalks in every row of each variety and

No. of plot	Variety	Time of planting	Time of maturing (approximately)	Weight of ear corn		Wt. of shelled corn		Per ct. of shelled corn	Avg. yield per acre
				lbs.	oz.	lbs.	oz.		bu.
1	Silver Mine.....	May 16	Sept. 7	94	..	77	12	82.7	....
2	"	" 16	" 7	88	12	74	8	83.9	....
3	"	" 16	" 7	63	12	54	..	84.7	49.1
1	Boone Co. White	" 16	" 24	136	12	108	8	79.3	....
2	" " "	" 16	" 24	117	4	90	12	77.4	....
3	" " "	" 16	" 24	110	..	83	8	75.9	67.3
1	Golden Eagle...	" 16	Aug. 30	88	12	76	4	85.9	....
2	" " ...	" 16	" 30	89	4	77	4	86.5	....
3	" " ...	" 16	" 30	76	8	67	..	87.5	52.5
1	Leaming........	" 16	Sept. 15	107	12	89	4	82.8	....
2	"	" 16	" 15	95	..	77	12	81.8	....
3	"	" 16	" 15	105	4	86	4	81.9	60.3
1	Reid's Yellow Dent	" 16	" 15	95	8	80	4	84.	....
2	"	" 16	" 15	115	8	96	8	83.5	....
3	"	" 16	" 15	96	4	80	..	83.1	61.1
Totals for entire plot	Silver Mine........			246	8	206	4	83.6	....
	Boone Co. White...			364	..	282	12	77.6	....
	Golden Eagle......			254	8	220	8	86.6	....
	Leaming...........			308	..	253	4	82.2	....
	Reid's Yellow Dent			307	4	256	12	83.5	....

again thinned to the number in the row containing the fewest stalks. In this way we secured an even test, for in each plot there were left an equal number of stalks of each variety. Dur-

ing the season the plots were given six cultivations, two with a Hallock weeder and four with a Sears cultivator. The average depth of cultivation was three and one-half inches. After the period of cultivation we again went through each plot, and any stalks that had been severely injured or broken during cultivation were removed. A count was then made of the remaining stalks of each variety and every plot was thinned to correspond to the plot having the smallest number of stalks. We did this to be certain that every variety represented had an equal chance for developing a uniform yield. The yield of the varieties, their time of planting, time of maturing, total yield per acre, etc., is shown by the table on the preceding page.

The time of maturing is given approximately in the above table because we were unable to secure the exact date on account of press of other work. In the variety experiment we also made a comparison of the tassel and silk development of the different breeds represented, a comparison of the time when all their pollen was shed, a comparison of the position of the ears upon the stalk with reference to the number of joints in the stalk, and a comparison of the number of good ears and barren stalks produced by the different varieties; but as the season was an unusually dry one, and as one year's observations are not sufficient to determine these points with any degree of certainty we do not feel justified in presenting them.

Our detasseling experiment was conducted on but a single plot of one-eighth acre. In detasseling we left the tassels on the outer row, removed them from the second, left them on the third, removed them from the fourth, and so on over the entire plot. The tassels were removed about the middle of July, and on November 26 the corn was gathered, each row by itself, and carefully weighed. The total weight of shelled corn from the rows not detasseled was 249 pounds, while the weight of the shelled corn from the detasseled rows was 300 pounds. We do not feel that these figures can be taken as an indication of the result that may be expected from detasseling corn in an average season. A part of the great increase in yield produced by detasseling may have been due to the extreme dryness of the summer. In an average season when there is a sufficient supply of moisture so

that the plant can secure enough food to develop a good ear, the injury done by removing the tassel is perhaps hardly compensated for by the increased yield, while in this season the plant food that the tassel would have required all went to develop the ear. Another reason for increased yield is perhaps explained by the fact that the prevailing breezes were from the southwest, and while not strong enough to carry the pollen very far, yet they carried it over to the detasseled rows and failed to carry it far enough to fertilize the rows beyond which had tassels.

The last experiment that we report is a trial of the different varieties of oats, and in this experiment we put to test an idea which we feel certain is of vital importance to the farmers of Illinois or any other state where oats are grown. Oats are usually sown at a certain rate per acre regardless of the size of the kernel or the vitality of the seed. As this practice is manifestly unreliable for testing the yield of varieties having different sized kernels and varying vitality, it was decided to adopt the following plan for determining the quantity of seed to be sown on the variety plots. Since average oats contain about one thousand kernels to the ounce, and as it was assumed that 2¼ bushels per acre of such oats, if all should grow, would give about the proper stand, it was decided to weigh out such a quantity of each variety as would give the same number of plants on equal sized plots, using as the standard 2¼ bushels of vital oats per acre when the size was such that 1,000 kernels would weigh an ounce.

For example, the number of kernels per ounce of any variety was multiplied by the per cent. of oats that would grow, and 1,152,000—the number of plants desired per acre—was divided by this product, the quotient representing the number of ounces of this variety to sow per acre. Of course it is necessary to weigh an ounce of the variety you wish to grow; then count the number of kernels in the ounce of weighed seed and test this seed to find its per cent. of vitality. This plan was found to be very satisfactory, and its use by farmers in general is recommended. If followed it would enable a farmer to determine what number of oat plants per acre produce the maximum yield of grain on his land, and also enable him to get almost exactly the same stand year after year.

The following table gives the result of the experiment and shows a great variation in the amount of the different varieties requiring to be sown. Each plot contained one-eightieth of an acre, and two plots were sown to each variety.

Variety	Source of seed	No. of kernels per oz.	Per ct. of vital oats	Ounces of seed sown per plot	Avg. yield per plot in pounds
White Bonanza...........	John A. Salzer	1003	93	15.4	9.7
Red Rust Proof.....	T. W. Wood......	986	94	15.5	14.3
Probstier.................	Peter Henderson ..	1054	87	15.7	20.
Imported Clydesdale	Peter Henderson ..	670	100	21.5	15.5
Black Tartarian..........	Peter Henderson ..	920	85	18.4	15.3
White Russian...........	Peter Henderson ..	1070	100	13.4	17.9
New Zealand.............	Iowa Seed Co.....	1141	94	13.4	17.7
Improved White Russian..	John A. Salzer	853	95	17.7	14.8
Giant Yellow French.....	J. C. Vaughan.....	1375	96	10.9	18.4
Lincoln..................	J. C. Vaughan.....	1128	99	12.6	14.9
Early Champion	Iowa Seed Co......	1733	83	10.	10.9
Lincoln..................	Iowa Seed Co......	1148	63	19.9	14.4
Nigger	Iowa Seed Co......	1477	85	11.4	14.4
Red Rust Proof	David Allen......	1094	91	14.4	15.3
Domestic Clydesdale.....	Peter Henderson ..	814	91	19.	11.
Great Northern	John A. Salzer.....	1248	96	11.9	12.5
Irish Victor	Iowa Seed Co.....	1190	50	24.2	16.8
Silver Mine	John A. Salzer.....	1215	98	12.	17.8
Improved Black Tartarian	J. C. Vaughan.....	1100	90	14.5	18.7
Golden Giant.............	W. Atlee Burpee..	1200	96	12.4	18.5
Welcome	W. Atlee Burpee..	877	85	19.3	17.3
White Bonanza...........	University of Ill...	1000	100	14.4	17.4

These few experiments show plainly enough the character of the work done by the students taking the course in field experiments, and while it may be unsatisfactory to some, and perhaps not as comprehensive as many would desire, yet we feel certain that any student who takes this branch of agronomy will feel amply repaid for the time and energy expended.

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